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The committee on wooden bridges and trestles went very thoroughly into the practice of pile driving this year, considering both the driving of wood and concrete piles. The principles of practice recommended for publication in the Manual have been worked up very carefully, as the few changes made by the convention in spite of the very thorough discussion show. Appendix B, including the principles of practice which were recommended for publication in the Manual, is to be commended for its conciseness. The Manual has been criticised at various times for the amount of explanatory matter included. To fully comply with its use as a guide for reference and not as a text book, the committees should be very careful to boil down their recommendations, and all explanatory matter should be excluded. Only by watchfulness in this regard can the Manual fullfil its best purpose.

The important subject of brine drippings and its relation to the corrosion of the metal portion of track and track structures is apparently disposed of, and dependence is now placed on the master car builders' ability to so construct refrigerator cars that this expensive destruction will be largely eliminated. Refrigerator cars are now being built in large numbers, and the total equipment is becoming enormous. A slight neglect on the part of a few lines would tend to cause continuance of the corrosion, requiring expensive renewals of track materials. While the Maintenance of Way Association may regard the subject as virtually closed, it is evident that the action of brine drippings on track is one of those evils which require eternal viligance, and further action is required by the Master Car Builders' Association and the American Railway Association, in formulating rules and penalties governing the matter.

The treatment of the report of the committee on Signals and Interlocking of the Railway Engineering and Maintenance of Way Association was chiefly noticeable for lack of discussion. This was a natural consequence of the fact that all the subjects presented had already been acted on by the Signal Association, and the action of this association was simply ratified. The only subject that provoked any remarks was that of bond wires. As was also brought out at the Signal Association meeting, it appears that though iron bond wires have been specified by the Signal Association and the individual roads since this device has been in use, for the past several years true iron has been unavailable and steel has been furnished instead. What is now sought is to make the specification conform to commercial possibilities. Apparently no one believes that true economy could be secured by the use of true iron, for though such bond wires are known to have lasted in service twice as long as mild steel, the cost is more than three times as much.

As will be seen by those who read the report on electricity, it strongly resembles the celebrated lecture of Josh Billings on "Milk," in which no mention is made of the subject in hand. The report dealt for the most part with the third rail and third rail clearances, and with the exception of the last two paragraphs of the recommendations, which deal with organization, it centers about the mechanical features of the third rail. The same holds true of the discussion. The recommendations of the committee were usually accepted without a word, while in cases where there was discussion it usually centered about some bit of verbiage rather than any real essential. For instance, the major portion of the debate was in regard to the determination of the gage line of the third rail, and, disregarding a mere word advocating the retention of the center line as the point of measurement, the talk was as to the whereabouts of the gage line and the definition of gage. So in the case of maintenance. The adoption of the recommendation turned on the use of the word "existing," it being specified that the work should be done by the existing maintenance of way organization. The word was finally left in place, with the understanding that some reference to electrified steam roads should be inserted. The discussion, therefore, while perhaps important, was perfunctory.

The question of providing adequate passenger terminal facilities is receiving unusual attention throughout the entire country. The enormous increase in passenger travel has outgrown most stations both in large and in medium-sized cities. Probably at no time have as many stations been in course of construction or under consideration as at the present time. Those of the New York Central and the Pennsylvania at New York; of the North Western at Chicago, and the Michigan Central at Detroit, Mich., the union station at Kansas City, Mo., the two union stations at Memphis, Tenn., and the union station at Tacoma, Wash., are but a few of the many large terminal stations under way; and there is a still larger number of places where plans are now being prepared and construction is but a short way off. The experience of the New York Central at

New York City and the North Western at Chicago should impress on the engineer the necessity of estimating very liberally the demands of future traffic. As Mr. Kittredge said yesterday in the discussion of the report on "Yards and Terminals," when the ordinance providing for the reconstruction of the Grand Central terminal expired in 1908, the amount of the station and terminal then finished was over 100 per cent. of the original estimate of the entire station, and the work done at that time provided but 40 per cent. of the facilities it was then necessary to plan to provide. The convention very wisely altered the recommendation of the committee by increasing the time for which demands must be anticipated from ten years to twenty years. The expenditure necessary for a passenger terminal is so great that much care should be taken to see that the full benefit be realized from it by securing the normal life from the building and layout. The committee called attention to the need of not only anticipating the demands of the future as far as it is possible to foresee them, but of also so making the design that expansion will be practicable should the increase in traffic exceed expectations. As the determining factors in the capacity of any terminal are facilities for free movement of trains in and out of train shed, and for the handling of express and baggage, special attention should be given to these factors. Trains must be able to move in and out at the same time without interference. With increasing state and municipal legislation, requiring the separation of street and railway grades, the number of stations with track levels either above or below the street level is increasing. This facilitates the handling of the baggage either above of below the track level —probably more commonly below. In separating these levels, greater facility is secured in handling both the baggage and the passengers.

THE TERMINAL ELECTRIFICATION PROBLEM.

President Fritch's address yesterday directed attention forcibly to the fact that government regulation now extends to every branch of the railway business. It first dealt with rates; it later was extended to safety appliances on equipment, and now it deals with so many phases of railway operation that it has become of direct importance to engineering, as well as other departments. The agitation of the subject of electrification in cities, for example—to which Mr. Fritch especially referred—is, of course, of particular interest to engineers.

There are two ways in which the railways can deal with questions such as this. One is to try to so educate public sentiment regarding railway affairs that the people will better understand what it is desirable and practicable to require of railways. The other is, to show public spirit and progressiveness by making such studies of the various questions of public interest that arise as Mr. Fritch suggested regarding the subject of electrification of terminals. When the public believes that the railways ought to do anything, it is the duty of railway officers to the public and to their stockholders either to show the public that the thing ought not to be done or to begin at once the necessary steps for accomplishing it. The Chicago railways long neglected to take such action as they ought in dealing with the agitation for electrification of their terminals. They are now beginning to set an excellent example in dealing with this subject. The presidents of the Northwestern, the Chicago & Western Indiana and the Burlington and the vice-president of the New York Central Lines have accepted appointments on a commission appointed by the Chicago Association of Commerce to make an investigation of the entire subject of terminal electrification. A chief engineer and a staff of assistants are to be appointed to do the work, and the railways have agreed to pay all the expenses involved. This is a move in the right direction. The fair spirit shown by the roads cannot fail to impress public opinion favorably, and the results of an investigation directed by a commission, including city officials, an eminent engineer, such as Dean Goss of the University of Illinois, prominent citizens and railway officers cannot fail to be much more enlightening than the results of one conducted by a body less representative.

A few years ago the city council of St. Louis created a Municipal Bridge and Terminals Commission to study the local terminal problem. Leading business men were appointed to it. The mayor was ex-officio chairman. After a thorough investigation the commission made certain recommendations to the railways for revision of their rates and improvement of their physical facilities. The roads made the rate changes suggested; they acquired at great expense the real estate necessary to make the physical improvements desired; and then the city council refused to pass the ordinances recommended by the city's own Bridge and Terminals Commission, and which were necessary to enable the roads to benefit by their purchases of real estate and make the needful improvements in their physical facilities.

The course of the city of St. Louis was utterly unfair to the roads. It is to be hoped that the Chicago lines will deal as fairly with their city as did the St. Louis lines, and it is to be hoped that if they do the city of Chicago, unlike the city of St. Louis, will give the roads in return a "square deal."

The results of the work of this Chicago commission will be followed with interest throughout the country, for, as President Fritch said, the question of electrification of terminals has become a live issue in several leading cities and the example set by Chicago in dealing with its very complicated terminal problem is apt to be followed by other cities in dealing with their much simpler terminal problems.

IMPACT TESTS.

The work done by the committee on iron and steel structures during the year 1910 is not as fully set forth in Bulletin 130 as the importance of the work done deserves. In Bulletin 125, published in July, 1910, are given the results of the work of the sub-committee on Impact up to that time, and in this report there is material which will repay study, not alone by maintenance officers or bridge engineers, but by operating and motive power officers as well. In the theoretical discussion of impact the counterbalancing of engines is shown to be the prime factor, while the design of the bridges is apparently one of less importance than it has, in the past, been considered. In the table showing the centrifugal force in percentages of the static load on drivers are some comparisons of engines of various types, used in the committee's tests, from the point of view of the amount of excess weight imposed on the rails by engines running at 60 miles an hour. In the last column of this table the percentage of increase over the static weight is shown for each engine, and in the wide variation between the several percentages, not only in the engines on different roads but also between different engines on one road, there is a suggestion that there may be room for improvement in methods of counterbalancing. It is hardly to be questioned that anything which will reduce the effect of impact on permanent way, whether it be on bridges or solid bank, will be a step toward both economy and safety.

It is of course true that in the table referred to both passenger and freight engines are shown, and that a speed of 60 miles an hour is probably more than should be used in determining the proper amount of counterbalance for a freight engine. At the same time the table shows several

passenger engines which have nearly a maximum effect at the assumed speed, and there is no doubt that these can be improved.

This work opens up an interesting field to the engineer, whose decision is final as to the running of a certain type of engine over existing bridges, some of them old and light. The amount of impact may be the determining factor in the unit stress computed, so that it becomes necessary to know with some exactness what should be the allowance. It is evident if the formula suggested by the committee be used in such a case, that if the engines concerned are counterbalanced to the best advantage the impact computed will be far in excess of the actual impact from the engine, and possibly the latter would be prohibited from running over bridges perfectly capable of carrying them with safety.

It becomes plain, then, that investigation into the amount of excess counterbalance possessed by the engine being considered will be desirable, and with this determined it will be sufficient to apply a factor to the formula proposed. Of course, as plainly stated in the report, the committee does not propose the formula as an impact formula for general use, but suggests only that it fairly represents the maxima results of the tests. It seems likely, however, that the formula as presented will, as in the case of the specifications for steel bridges, find wide use. Aside from the publication of results, including the comprehensive theoretical discussion, the sub-committee has done little in the past year. It is proposed to extend the tests this year to the investigation, by new and more delicate devices, of short spans, including some of reinforced concrete; sufficient funds, previously furnished by various railways, are available for the purpose. While the determination of impact on short spans has heretofore resisted all attempts at accuracy, there is good reason to believe that the committee will succeed in obtaining results comparable with those from its work on longer spans. It is worth the trial, and the support, both of the association and of the railways, should be given the work. As a matter of fact, the continuance of such tests, year by year, would, at very moderate cost, give the railways and the engineering profession data which would be of great value, in ways which may perhaps be obscure now but which will in time be evident.

In Bulletin 130 the committee presented specifications for bridge erection for discussion by the association and recommended their adoption. There is no doubt that these also will be valuable and will admirably supplement the specifications already worked up by the committee and adopted by the association.

PROGRAM.

Convention Program.

(Order may be changed by a two-thirds vote of the convention or by time required for consideration of reports.)

Wednesday, March 22.

Morning Session, 9 a. m. to 12:30 p. m.
Afternoon session, 2 p. m. to 5:30 p. m.
XVI. Economics of Railway Location.
II. Ballast.
III. Ties.
V. Track.
IV. Rail.
VIII. Masonry.
XIII. Water Service.
IX. Signs, Fences and Crossings.

Reception and Dinner.

Reception at 7 p. m. in Francis I room, Congress Hotel, followed by annual dinner in Gold room.

MEETING OF SIGNAL APPLIANCE ASSOCIATION.

The Signal Appliance Association held an informal meeting at the Coliseum at 11 o'clock Tuesday morning, March 21. The meeting was called to discuss arrangements for the annual convention at Colorado Springs next October, and various matters in connection with the action of the association at that time were discussed. It was decided to appoint a committee to look into the matter of transportation and rates to and from the place of meeting, and a formal meeting of the committee is planned for Thursday, March 23.

ENGINEERS' VISIT TO THE EXHIBIT.

It was decided at yesterday's meeting that the convention shall adjourn at 4 o'clock p. m. to-night, in order to give the members of the association an opportunity to go in a body to inspect the exhibit of railway appliances at the Coliseum.

In announcing the early adjournment of the convention for the purpose of making this trip to the Coliseum, President Fritch said: "The Railway Appliance Association has done itself proud this year in establishing one of the finest exhibits of railway appliances ever made, and I think it is due to the Railway Appliance Association that we show our appreciation of their efforts and visit this exhibit as much as our time will permit."

INVITATION TO VISITING ENGINEERS FROM CHICAGO ENGINEERS' CLUB.

Robert Isham Randolph, secretary of the Chicago Engineers' Club, has sent to President Fritch of the American Railway Engineering and Maintenance of Way Association, the following invitation to visiting engineers on behalf of the board of directors of the club:

"The Board of Directors of the Chicago Engineers' Club extends a cordial invitation to the members of the American Railway Engineering and Maintenance of Way Association to make use of the rooms and facilities of the Chicago Engineers' Club during the week of your convention. Guest cards can be obtained from Frank Coates, on the first floor of the Auditorium Annex."

MEETINGS OF BURLINGTON SIGNAL DEPARTMENT EMPLOYEES.

The signal department of the Chicago, Burlington & Quincy is planning to hold meetings of the employees at regular intervals, to discuss matters pertaining to the work of the department. The lines east and the lines west will have separate meetings. This plan will be put into effect immediately, and the first meeting will be held on Wednesday, March 22. The supervisors who will be in attendance will take advantage of the opportunity to visit the exhibition at the Coliseum during the day.

ANNUAL DINNER TO-NIGHT.

President Fritch will be toastmaster at the annual dinner of the American Railway Engineering and Maintenance of Way Association in the gold room of the Congress Hotel to-night. The dinner will be preceded by a reception at 7 o'clock, in the Francis I room, which immediately adjoins the gold room, and the receiving party will include the principal officers of the association and some of the past-presidents. The attendance at last year's dinner was 304, and present indications are that this year's attendance will be 350, or, perhaps, even 375. Among the invited guests who have indicated their intention to attend is Daniel Willard, president of the Baltimore & Ohio, who is president also of the American Railway Association.

The list of speakers has been somewhat changed, owing to

the inability of John F. Wallace and B. L. Winchell to be present. The speakers, in their order, probably will be as follows:

S. M. Felton, president Chicago Great Western; Rev. Dr. F. W. Gunsaulus; Judge John Barton Payne, general counsel Chicago Great Western; Sir Thomas R. Price, commissioner of South African government railways and harbors; William B. Poland, vice-president and chief engineer, Philippine railways, and Rev. R. A. White, pastor of the People's Liberal Church, Chicago.

Tickets can be procured from the arrangements committee, room 1166. Music for the dinner will be furnished by Klohr's orchestra, which also furnished it last year.

SIGNAL ASSOCIATION COMMITTEE MEETINGS.

Quite a number of the Railway Signal and the Maintenance of Way Association committees are taking advantage of the fact that all or nearly all of their members are here this week to hold committee and subcommittee meetings. Among these, the Committee on Methods of Recording Signal Failures of the Signal Association will hold a meeting at the Congress Hotel at 9:30 Wednesday morning, March 22. J. C. Young, signal engineer of the Union Pacific, is chairman of this committee. Committee II on Mechanical Interlocking of the Signal Association will meet at the Congress Hotel at 10 o'clock Wednesday morning, March 22.

ELECTRIC RAILWAY OFFICERS INSPECT SIGNAL EXHIBIT.

The Committee on Signaling of the Central Electric Railway Association held a meeting Tuesday morning and visited the Coliseum in a body and made a thorough inspection of the signaling exhibits. The members were particularly interested in the systems of signaling which have been designed for the handling of interurban traffic at a cost which can be met by the small railway. These systems are constructed with a view to their amplification and extension as conditions warrant, so that any road can use them as a basis for ultimate complete block system protection. This committee is to make a report to the Indiana Railroad Commission.

A RECORD-BREAKING ATTENDANCE.

It is probable that the attendance at the Maintenance of Way Convention yesterday broke all records for a first day's session. The registration of members up to 5 o'clock p. m., numbered 314. Last year the registration up to the same hour was only 251; and that compared very favorably with the record of any previous year. The meeting room was pretty well filled during both the morning and afternoon. It being officially the first day of Spring, the weather man ran the temperature up pretty high; and there was considerable complaint about the meeting room being too warm, in spite of the fact that it was well ventilated.

EXTENSIVE ADDITIONAL TRACK ELEVATION IN CHICAGO.

An ordinance has been presented to the city council of Chicago providing for the elevation of the tracks of the Illinois Central from Seventy-ninth street, the end of the present elevation, south to Kensington avenue, a distance of about five miles, together with the Chicago, Rock Island & Pacific's South Chicago branch from State street to Jeffrey avenue, the Chicago & Western Indiana from State street to Stony Island avenue, the Dolton branch of the Chicago & Western Indiana from One Hundred and Eleventh street to the Illinois Central at One Hundred and Nineteenth street, the Belt Railway of Chicago from Pullman Junction to Jeffrey avenue, and the New York, Chicago & St. Louis from Seventy-ninth street to Stony Island avenue.

The essential details of this ordinance have been agreed to by the city track elevation department and the railways concerned, and it is expected that the ordinance will be passed within the next ten days. The separation of the grade crossings at Burnside and Kensington, and the Nickel Plate-Illinois Central crossing are left optional with the roads concerned. The estimated cost of the Illinois Central portion of this work, exclusive of the additional cost of separating grade crossings, will approximate $2,250,000, while the cost to the other roads will at least equal that amount. The ordinance requires that the Illinois Central, the Michigan Central and the Kensington & Eastern (Illinois Central) have their work completed in 1916, while the other roads have until 1918.

The amount of track involved is approximately as follows:

Location—	Roadway.	Track.
Illinois Central, East 79th street to Kensington avenue	4.85	69.07
Nickel Plate, East 79th to East 95th street	2.21	29.02
Rock Island, South State street to Jeffrey avenue	2.38	5.56
Western Indiana, South State street to Stony Island avenue	2.23	12.09
Same, East 111th street to Illinois Central tracks	1.30	3.10
Belt Railway, Pullman Junction to Jeffrey avenue	.72	2.41
Kensington & Eastern, East 111th street to Kensington avenue	.50	1.00
Michigan Central, East 113th street to Kensington avenue	.38	.72
Total	14.57	122.88

ELECTRIFICATION OF CHICAGO TERMINALS.

The Chicago Association of Commerce has been investigating the electrification problem of the Chicago railway terminals for the past 18 months. As a result of this study a commission of 17 railway executives, city officials and business men has been appointed to make a thorough investigation of this subject, going into all of its phases. The railways are co-operating in this movement and they have agreed to pay all the expenses of the investigation. In order to attain the best results possible a chief engineer and a staff of assistants will be engaged to study the engineering problems involved. A permanent organization will be effected at an early date.

The following men were appointed on this commission: W. A. Gardner, president Chicago & Northwestern; H. G. Hetzler, president Chicago & Western Indiana; Darius Miller, president Chicago, Burlington & Quincy; C. E. Schaff, vice-president New York Central Lines; Paul P. Bird, chief smoke inspector of Chicago; Dr. W. A. Evans, commissioner of health; Milton J. Foreman, chairman local transportation committee of the city council; W. F. M. Goss, dean of College of Engineering of University of Illinois; E. R. Graham, of D. H. Burnham & Co.; Richard C. Hall, president Duck Brand Company; Jesse Holdom, attorney at law; Harrison B. Riley, president Chicago Title & Trust Company; John W. Scott, of Carson, Pirie, Scott & Co.; Francis T. Simmons, of Francis T. Simmons & Co.; Mason B. Starring, president Northwestern Elevated Railroad; Frederick H. Rawson, president Union Trust Company.

The personnel of this committee is largely the same as that of the railway terminal commission appointed by Mayor Busse. (See Railway Age Gazette, February 24, page 372.)

ANNUAL MEETING OF THE RAILWAY APPLIANCES ASSOCIATION.

The Railway Appliances Association held its annual meeting in the Coliseum Tuesday morning. The minutes of the last meeting were read and approved. The treasurer's report showed a surplus of $4,869.92 in hand from last year, and a satisfactory estimate of the probable expense of the exhibit now being given.

The election of officers resulted in the selection of Robert E. Belknap, Pennsylvania Steel Co., president; A. P. Van Schaick, Lackawanna Steel Co., vice-president; John N. Reynolds, Railway Age Gazette, secretary and treasurer.

The executive committee selected is composed of C. W. Kelly, Fairbanks, Morse & Co.; Thomas R. Wyles, Detroit Graphite Co.; George C. Isbester, Q. & C. Co.; N. M. Hench, Carnegie Steel Co.; S. W. Hayes, Hayes Track Appliance Co.; H. M. Sperry, General Railway Signal Co.; T. W. Snow, ex-president, ex-officio, on board of directors.

FOREIGN OPINION OF THE A. R. E. & M. OF W. ASSOCIATION.

Just after the opening of the afternoon session yesterday, William McNab, principal assistant engineer of the Grand Trunk, and a past president of the association, took occasion to make a statement illustrating foreign opinion of the work of the association.

"Before the committee on yards and terminals presents its report," said Mr. McNab, "I want to quote from a letter which I received two months ago from the general manager of one of the leading railways of Great Britain to show in what esteem this association is held in Europe. The quotation is in connection with this particular committee. I had sent him a copy of our transactions of last year. He says:

"'I have delayed replying to you until I could find an opportunity to peruse the volumes. I have now done so. I must say that I found them most interesting. I was in particular interested in the plans of the terminal stations, and I have shown this part of the report to our chairman, Chas. Renshaw, in connection with the reconstruction of a large terminal station, which we have under way at the present time.'

"I present this extract from this letter, not to throw any bouquets at this committee, but to show the whole association that we are recognized across the seas."

BRENNAN MONO-RAIL CAR.

One of the features of the exhibition at the Coliseum this week which is attracting universal attention is the model of Brennan's Mono-Rail Car, which makes trips from one side of the balcony to the other at the south end of the building. Mr. Brennan, the inventor, gives daily demonstrations and lectures on the remarkable and little understood gyroscope principles involved in his car. These lectures take place in the morning at 10, 11 and 12 o'clock; in the afternoon at 2, 3, 4 and 5 o'clock; and in the evening at 8, 8:30 and 9 o'clock. There are two models of the car on exhibition, the larger one having five times the power of the smaller. These are shown running on a cable swung free from one side of the balcony to the other, and also running on a curved track. The smaller model is the style usually used in schools, but the large one was made especially for this exhibition and is to be presented to one of the universities or technical schools of the United States at the close of this exhibit. The award is to be made by a vote of the railway officials present, the vote to be by ballot. These ballots may be obtained at the Bureau of Information, Booth "A," in the center of the main aisle.

Proceedings.

The first session of the twelfth annual convention of the American Railway Engineering and Maintenance of Way Association was called to order at 9:30 a. m. on Tuesday, March 21, in the convention hall of the Congress Hotel, by the president, L. C. Fritch, chief engineer of the Chicago Great Western.

The minutes of the last meeting were approved, without reading, and the president then read his annual address.

PRESIDENT'S ADDRESS.

To the Members of the American Railway Engineers and Maintenance of Way Association:

The progress made by the association during the year just passed has been gratifying, and the thanks of the association are due its committees for their efficient and painstaking labors and the splendid results secured. That interest and enthusiasm in the work has been sustained, is attested by

L. C. Fritch, President.

the fact that all of the twenty-two standing and special committees have presented valuable and comprehensive reports for consideration at this convention.

It is noteworthy that in the midst of the busy lives of the members, time is found to accomplish so large an amount of work, and to perform it in the efficient and thorough manner in which it is presented. This feature is all the more praiseworthy, when it is considered that this organization is a voluntary one, and the time devoted by the members to committee work is frequently given at a great personal sacrifice and at the expense of much-needed rest.

Prior to the formation of the association few railways pursued the same methods, or used similar appliances or devices, in so far as railway engineering and maintenance of way work was concerned, even under similar climatic, physical and commercial conditions, and there was little, if any, approach to uniformity as to methods and practices. A fertile field seemed, therefore, to exist, in which it was

believed much good might be accomplished, by formulating principles of practice and disseminating knowledge pertaining to maintenance of way work.

This association was formed for "the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways," and to attain those ends it was deemed essential to investigate matters pertaining to the objects of the association through standing and special committees; to hold meetings for the discussion of papers and reports; to publish its conclusions and to maintain a library.

The founders of the association wisely concluded that the best results would be obtained through committees, the members of which should be selected with due consideration of their qualifications to deal with particular subjects.

The work of the association was laid out on unique lines. The entire field of railway engineering and maintenance of way work was originally divided into sixteen divisions, and a committee appointed to deal with each subject. Now we have nineteen standing committees, and additional special committees to consider matters not coming within the province of the regular committees.

Each committee is given a particular phase of the general subject, and they are requested to collect all available information on the subject in hand, to digest carefully the data obtained, to draw therefrom such conclusions as the information seems to warrant, and to submit to the association its recommendations thereon. Committee reports are to be formulated on the following general plan: An historical review of the subject under discussion, with an outline of its origin and development; an analysis of the most important elements of the subject-matter; an argument, showing the disadvantages of the old and the advantages of the recommended practice; and, finally, the conclusions of the committee, giving in concise language and in logical sequence its conclusions and recommendations. That these methods have been productive of excellent results is abundantly shown in our proceedings for the past decade.

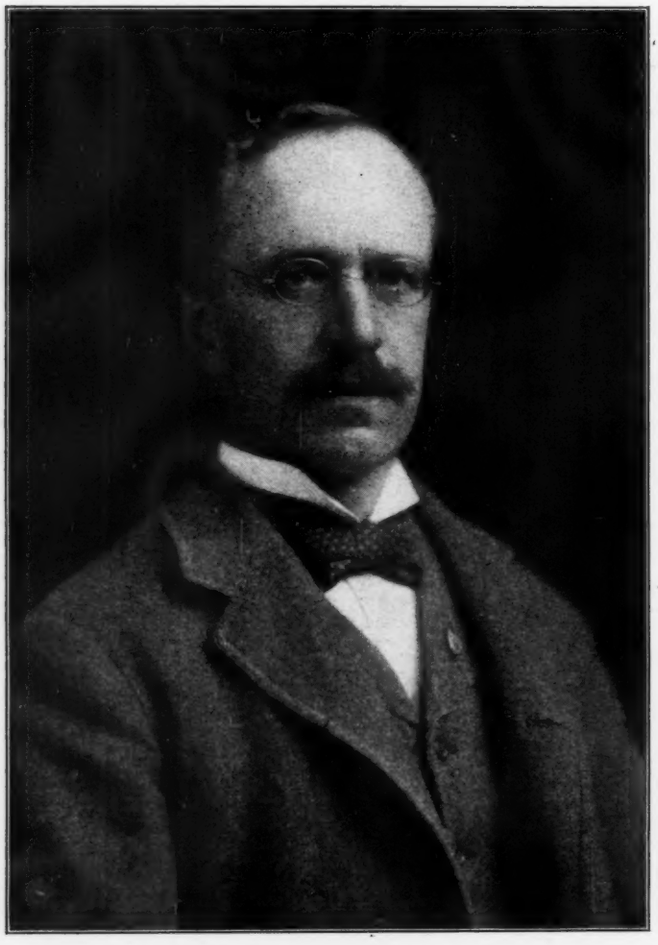
However, the formulation of principles of practice is not the only or main function of our association. The collection and dissemination of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways is quite as important, and it will be conceded that along these lines the association has made an enviable record. Since the formation of the association there have been issued over twenty thousand pages of printed matter, all of it live and useful material pertaining to our profession.

While it may be true that not all of our recommendations have met with universal approval, nevertheless they have served as a guide to the engineer in arriving at a solution of his problems. It would be practically impossible to formulate principles of practice applicable to all sections of the country, with its diversity of conditions of soil, climate and commercial requirements.

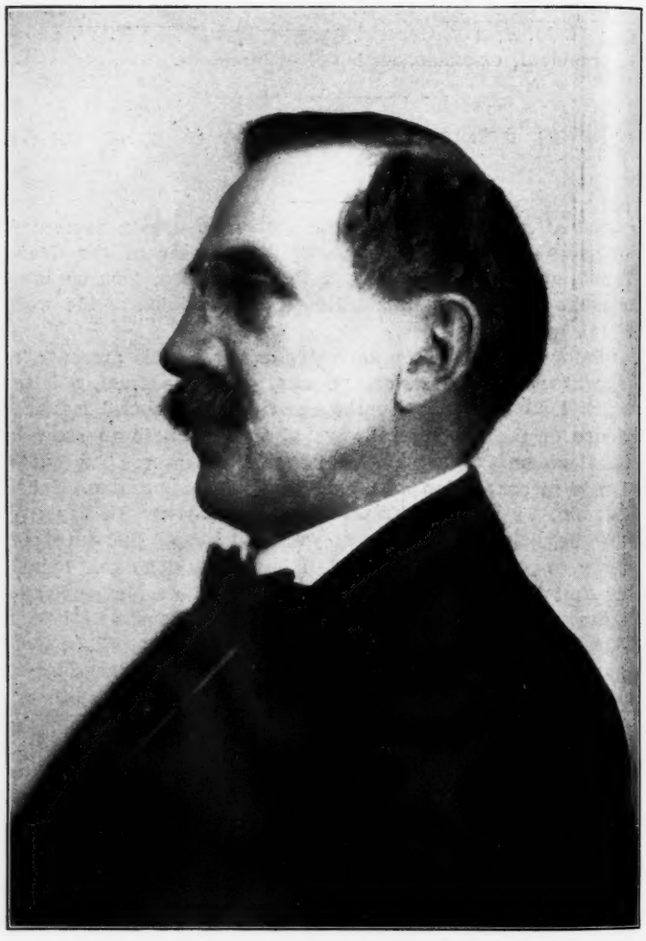
Some of our critics have said, "your association is gathering an immense amount of valuable information, but your conclusions are not always sound. Your committee reports need boiling down, the wheat needs winnowing from the chaff."

My own opinion is that there is no foundation for these criticisms, which is evidenced by the fact that our proceedings are used as works of reference by the ablest engineers, not only of this country, but of the world.

There is a Roman adage that says, "whatever you do, do it well, and always consider the consequences of what you do." This is wise counsel, and, in my judgment, it applies to our own work. We should be careful not to spend too much time and effort on details and peculiar methods and neglect underlying principles upon which all good practice is founded. We should aim at principles that may be universally applied. For example, good, sound specifications covering the materials of engineering, which are susceptible of universal application, are of more use than methods or particular plans or designs, which have only limited application. The work of our association that will stand out prominently is that which is of the greatest use to the greatest number.



W. C. Cushing, First Vice-President.



C. F. Loweth, Treasurer.

Perhaps too much stress is laid upon the establishment of standards. In a progressive art, such as ours, there should be no such word as "standard." What is standard to-day may be obsolete to-morrow. Improvement and advancement is the order of the day, and in no profession is this truer than in our own.

The progress of railway engineering during the past year is perhaps best exemplified in the opening for service of the New York terminals of the Pennsylvania, including the tunnels under the Hudson and East rivers. This great achievement, made possible only by the ability, foresight and courage of that splendid type of man and engineer, Alexander J. Cassatt, is a fitting and lasting tribute to his genius and memory. It marks an epoch in railway progress, being the first large trunk line railway terminal, complete in its operation with the use of electric traction. This installation awakens us to the sense of a new responsibility that is placed upon us as engineers, and that is, that we should prepare ourselves for the new problems that it will be our duty to solve. It will devolve upon the engineers of our railways to determine to what extent this new power is justifiable in heavy trunk line service. The question of electrification of trunk lines, and its application to terminals in large cities, has assumed the proportions of a public question in the cities of Boston, Philadelphia, Baltimore, Washington, St. Louis, Chicago, and its extension in New York City to all classes of service is being considered.

It is a problem of great magnitude and involves not only technical skill, but judgment of the highest order, and its solution must, in the final analysis, be made by railway men, familiar with the intricacies of railway operation and its needs. My advice, therefore, would be, that railway engineers prepare for this economic change that has already begun, in order that the problems that demand solution may be solved on a sound basis, and that costly mistakes which ignorance would otherwise impose, may be avoided.

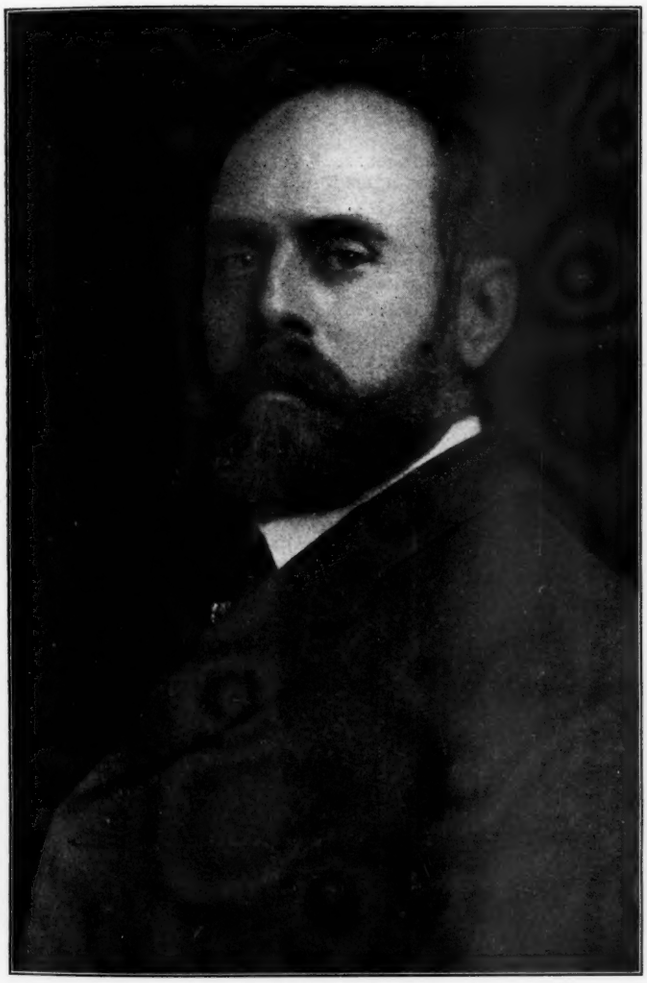
We will miss some familiar faces at this convention—men who have aided us in placing this association on its high plane of usefulness. Among those who have gone to that "other country from whose bourne no traveler ever returns" are Octave Chanute and Samuel M. Rowe, both pioneers in the art of wood preservation; E. P. Dawley, an efficient member of the committee on electricity; John F. Hinckley, a valued member of the rail committee; Ira G. Rawn, an able member of our first committee on yards and terminals; J. E. Schwitzer, late chief engineer of the Canadian Pacific, a valued member of the committee on economics of railway location; H. L. Laughlin, an efficient member of the committee on track.

A notable achievement made during the past year, through the co-operation of the Master Car Builders' Association and our association, is the final solution of the question of the disposal of brine drippings from refrigerator cars, which has been the bane of railways for nearly thirty years. The conclusion reached provides for retaining the brine drippings in tanks between icing stations, and draining them at given points, where facilities are provided for that purpose. This will result in preventing injury to maintenance of way structures and equipment costing the railways in the past thousands of dollars.

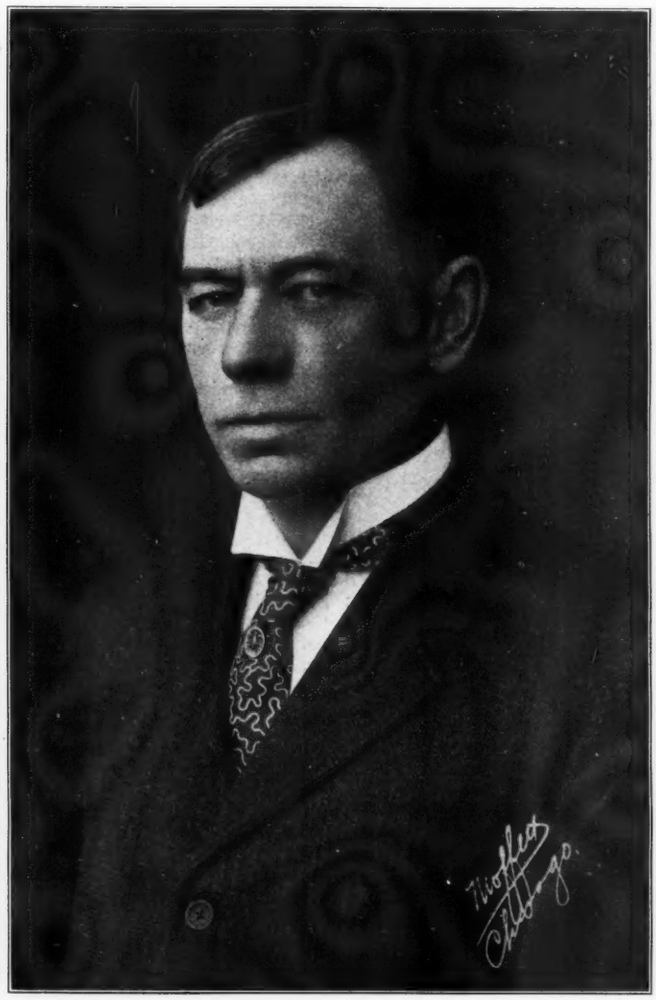
There are two important matters coming before this convention for final vote. The name of the association, which has been unfortunately cumbersome in its length, is to be changed to one of shorter length, a desirable innovation.

The proposed change in the constitution, which will grant to the membership at large a voice in the selection of officers of the association, is one that will meet with universal approval.

The railway industry is being circumscribed by governmental regulations to the extent that its operations, to the minutest details, are being regulated by law or prescribed by rules of commissions created under federal or state authority. Some of these regulations are wise and beneficial, and were necessary to purge the railway business of its



Chas. S. Churchill, Second Vice-President.



E. H. Fritch, Secretary.

past sins of omission and commission. However, many of the regulations, conceived by irresponsible persons and for sinister purposes, are a positive menace to the public they were designed to benefit; these will serve no good purpose, but prove a positive check to railway development. In this feature we are vitally interested, and it devolves upon us as citizens, true to our calling, to educate the public to a realization of the rights and the justice that is due the railway industry.

It has been asserted that railways are extravagant and wasteful in their methods of operation, and lack system in conducting their business. These charges are not in accordance with the facts as we know them. Organizations similar to our own are giving their best thought to the improvement of methods and to the promotion of efficiency in all departments of railways.

We have an abiding faith in the fairness and common sense of the American people, and that our incomparable country will progress with undiminished momentum. New lines of railways will continue to be built, existing lines will be revised and rebuilt, and herein lies our duty.

The charter of our existence provides that we shall devote ourselves to the "advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways." We maintain that our association has justified itself and that in the future, as in the past, we will endeavor to do our work honorably, thoroughly and conscientiously, irrespective of regulations, as is the desire of every member of the American Railway Engineering and Maintenance of Way Association.

In closing the term of office as president, I wish to thank the board of direction for its hearty co-operation, the secretary for his untiring devotion to duty, and the committees for the splendid work which they have accomplished.

The report of the secretary and treasurer showed the following statements:

Total membership at last annual convention		869
Withdrawals during the year	11	
Deceased members	7	
Dropped for non-payment of dues	20	
	38	38
		831
Additions during the year		136
Total membership, March 15, 1911		967
Consisting of:		
Active members	908	
Honorary members	3	
Associate members	56	
	967	

Geographical Distribution.

The geographical distribution of the membership is indicated in the following table:

United States	838	Panama	2
Dominion of Canada	76	Australia	1
Mexico	14	Brazil	1
Japan	7	Germany	1
Cuba	6	Great Britain	1
China	5	Guatemala	1
New Zealand	4	Peru	1
Philippine Islands	4	Russia	1
India	2		
Korea	2	Total	967

Classification of Members.

The positions held by the members are indicated in the following table:

Presidents	16
Assistants to President	3
Vice-Presidents	28
General Managers	18
Director Maintenance and Operation	1
Assistant Director Maintenance and Operation	1
Assistant General Managers	6
General Superintendents	10
Assistant General Superintendents	2
Division Superintendents	34
Chief Engineers	114
Assistant Chief Engineers	24
Principal Assistant Engineers	15
Chief Engineers Maintenance of Way	6
Assistant Chief Engineers Maintenance of Way	1
Engineers of Construction	12
Engineers Maintenance of Way	89
Bridge Engineers	28
Engineers Surveys	1
Tunnel Engineers	1
Division Engineers	90
Assistant Engineers	97
District Engineers	14
Electrical Engineers	4
Inspecting Engineers	11
Supervising Engineers	3
Architects	5
Locating Engineers	3
Engineer Track Economics	1
Engineers Track and Roadway	5
Designing Engineers	2
Maintenance of Way Accountant	1
Engineer B. & B.	1
Office Engineers	7
Chief Draftsmen	5
General Roadmasters	2
Roadmasters	14
Master Carpenters	3
Rail Expert	1
Superintendent Bridges and Buildings	3
Supervisors	2
Resident Engineers	30
Signal Engineers	20
Assistant Signal Engineer	1
Managers Timber Department	5
Timber Inspector (Chief)	1
Forester	1
General Foreman Water Works	1
Supervisor Materials	1
Chemists and Eng. Tests	2
Metallurgical Engineers	2
Engineer River Protection	1
Professors in Colleges	16
Associate Professors	16
Government Employes	13
Civil Engineers	59
Consulting Engineers	75
Contracting Engineers	20
Engineer Grade Elimination	2
Purchasing Agent	1
General Agents	2
Receiver	1
Editors	3
Miscellaneous	6
Total	967

Financial Statement.

Balance on hand March 12, 1910	$15,382.57
Receipts during the year	26,423.95
Expenditures during the year	28,593.49
Excess of expenditures over receipts	$ 2,169.54
Balance cash on hand March 15, 1911	$13,216.62

Wm. McNab (Grand Trunk Railway): Before the business of the association begins, may I be allowed to express to the members of the association the regret of Past-President Howard G. Kelley at his inability to be present at these sessions? Mr. Kelley is in Southern California, having taken his wife there to recuperate after a severe illness. This is the first convention since the inception of this association that Mr. Kelley has missed. His disappointment at his non-attendence is keen, but I do not think it is any more so than the members of this association feel at the present time at his absence. I ask your indulgence in allowing me to make these remarks, so that Mr. Kelley's regrets may go on record.

RULES AND ORGANIZATION.

In connection with the work of the committee, books of rules of 61 American railways have been secured and a compilation made showing the subjects covered by them. A few of these rules have been selected and are now presented as an appendix to this report. These rules cover the following subjects:

I. Absence from duty.
II. Accidents.
III. Ballast—covering the purpose for which ballast is used, material, cross-section, preparation of sub-grade, handling, tamping, surfacing, etc.
IV. Batteries—covering the duties of battery-men and care of batteries.
V. Cars—relative to loading and unloading of roadway material.

VI. Deportment.
VII. Discharging men.
VIII. Drainage.

Under the first of the instructions of the board of direction the committee recommends the following changes in the Manual:

Rule 4 under "General Notice" shall be revised to read:

"4. Employees must exercise care and watchfulness to prevent injury to themselves, other employees and the public, and to prevent damage to property. In case of doubt they must take the safe course. They must know that all tools and appliances are in safe condition before using. They must move away from tracks upon approach and during passage of trains, and, so far as practicable, prevent the public from walking on tracks or otherwise trespassing on the right-of-way."

Under the heading "General Notice," add two additional new rules as follows:

"10. Employees must not without proper authority absent themselves from duty, exchange duties with others or engage substitutes."

"11. Employees must conduct themselves properly at all times. They must be civil and courteous to fellow employees and patrons of the road. Employees who are dishonest, vicious, quarrelsome, or use profane, vulgar or immoral language, must be discharged."

Under "Rules Governing Track Foremen, Bridge and Building Foremen and Signal Foremen," Rule 4 in each case shall be revised to read:

"4. They shall employ men as the ——(Title)—— directs. They must treat employees with consideration, and see that they properly perform their duties. They must discharge men

J. O. Osgood.

Chairman, Committee on Rules and Organization.

who are incompetent or neglect their duties, but in no case shall they discharge men without cause. They must keep the required records of the time of their men and of the materials used."

Under "Rules Governing Track Foremen," Rule 5 shall be revised so that the last clause shall read:

"Foremen must provide themselves with reliable watches, and, when possible, compare time daily with a standard clock or with the watches of other employees who are required to have the standard time."

Under the second instruction of the board of direction it is recommended that Rules 1, 2, 3, 4, 5 and 6, under the heading "Inspection of Track," now published on page 66 of the Manual, be omitted in future revisions.

Under the third instruction it is recommended that the instructions to next year's committee provide that rules in the nature of specifications or instructions regarding the conduct of work be prepared, making use of the recommendations of the various committees dealing with these subjects, and of the best practice of the railway companies as embodied in their Books of Rules, with a view to providing material which may be of assistance to railroads formulating maintenance of way rules.

The report is signed by: Jos. O. Osgood (C. R. R. of N. J.), chairman; F. L. Nicholson (N. & S.), vice-chairman; F. D. Anthony (Q., M. & S.), G. D. Brooke (B. & O.), S. E. Coombs (N. Y. C. & H. R.), E. J. Correll (M. P.), B. T. Elmore (Virginian), A. S. More (C., C., C. & St. L.), G. L. Moore (L. V.), D. B. Johnston (Pennsylvania Lines), D. W. Richards (N. & W.).

APPENDIX A.

Suggestions for New Rules.

In connection with the work of the committee this year books of rules of 61 American railways have been secured and a compilation made showing the subjects covered by them. These rules have been studied and suggestions for new rules are here made for a number of subjects.

Absence from Duty.

Employees must not without proper authority absent themselves from duty, exchange duties with others or engage substitutes.

Accidents.

General.—Track foremen must, in case of accident, promptly render all assistance in their power, whether the accident occurs on their own or adjacent sections. They shall investigate and report on Form No. ..... all accidents occurring on their sections, which may be attributable to, or result in damage to, track, roadbed or structures, and preserve all materials which may assist in determining the cause.

Watchmen.—Track foremen must, in case of accident, promptly render all assistance in their power, whether the accident occurs on their own or adjacent sections, and when necessary appoint watchmen to guard the premises and prevent stealing. They shall investigate and report on Form No. ..... all accidents occurring on their sections, which may be attributable to, or result in damage to, roadbed or structures, and preserve all materials which may assist in determining the cause.

Accidents to Individuals.—Employees must exercise the greatest care and watchfulness to prevent injury or damage to themselves, other employees, the public and to property, and in case of doubt take the safe course. They must know that all tools and appliances are in safe condition before using, move away from tracks upon approach and during passage of trains, and, so far as practicble, prevent the public from walking on tracks or otherwise trespassing on the right-of-way.

Ballast.

Purpose.—Ballast is used for the purpose of securing a solid bearing for the ties, holding them firmly in position and supporting the tracks as uniformly as possible, distributing the trainloads over the roadbed, providing rapid and efficient drainage, and preventing as far as possible the freezing of the roadbed.

Material.—Ballast shall be of broken stone, gravel, slag, cinders, chats, chert, burnt clay, gumbo or disintegrated granite. The selection of the particular kind of ballast to be used shall be determined by the title.

Quality and Size—Broken Stone.—Broken stone ballast shall be clean, free from earth and all foreign substances, of the quality and sizes required under the company's specifications for stone ballast.

Quality, Etc., of Gravel.—Gravel ballast shall be of a uniform size, clean and free from fine sand, loam, clay and stones which will disintegrate or cause rough riding track.

Quality, Etc., of Cinders.—The use of cinders as ballast is recommended for the following situations: On branch lines with a light traffic; on sidings and yard tracks near point of production; as sub-ballast in wet, spongy places; in cuts and on fills; as sub-ballast on new work where dumps are settling, and at places where the track heaves from frost. It is recommended that provision be made for wetting down cinders immediately after being drawn.

Quality, Etc., of Burnt Clay.—The material should be black gumbo or other suitable clay free from sand or silt. The suitability of the material should be determined by thorough testing in a small test kiln before establishing a ballast kiln.

The material should be burned hard and thoroughly.

The fuel used should be fresh and clean enough to burn with a clean fire. It is important that a sufficient supply be kept on hand to prevent interruption of the process of burning.

Burning should be done under the supervision of an experienced and competent burner.

Ballast should be allowed to cool before it is loaded out of the pit.

Absorption of water should not exceed 15 per cent. by weight.

Depth of Ballast.—The depth and slope of the ballast shall conform to the standard section for the particular kind of ballast to be used.

Preparation of Subgrade.—Track centers and grade lines shall be given by the engineer previous to ballasting track. The subgrade shall be properly prepared for ballast; all unsuitable material above the bottom of the ties removed, and

banks widened to retain the ballast and secure good drainage. The track shall then be thrown to line and the ballast delivered.

Open Track, Etc.—Track shall be kept in good line and surface when ballasting, and shall be carefully watched to avoid rail buckling and throwing track out of line.

Mixing Ballast With Old Material.—Care shall be taken in handling ballast to prevent mixing with earth, or with old, unsuitable material between and around the ends of ties, or wasting down the slopes of embankments. Ballast forks should be used exclusively for handling broken stone and slag ballast.

Embankments Not Well Settled.—On embankments that are not well settled the surface of the roadbed shall be raised with suitable material. Material for this purpose shall not be taken from the slopes of the embankments.

Tamping.—Ballast shall be well and thoroughly tamped at each end of the ties, directly under and about 15 in. on each side of the rails. The center shall be filled and lightly tamped.

Tamping picks shall be used for tamping broken stone and slag ballast.

Bonded Rails.—Ballast shall not be allowed to come in contact with rails where bonded. At points where it is impossible to prevent such contact, broken stone or clean gravel ballast shall be used.

Surfacing.—The general surface of track must not be raised without proper authority.

Trimming, Etc.—After ballast is placed it shall be neatly trimmed, track accurately gaged and properly surfaced and lined to conform to the standard drawing.

Filling Between Tracks.—The space between double tracks up to the underside of the ties shall be filled with coarse stones and then be leveled off with standard ballast up to the tops of ties.

Heaving, Etc.—When track becomes foul, churns, heaves, or wet spots develop, the bad material shall be removed to the depth and in the manner required to secure drainage and the space filled up with good material.

Batteries.

Batterymen.—Batterymen shall report to, and receive instructions from, the ..... (Title.)

Responsibility.—They shall be responsible for the proper inspection and safe condition of all batteries and connections under their charge.

Batteries (Inspection).—They must inspect all batteries in their districts at least once each week and make renewals as frequently as necessary to maintain constant voltage.

Records.—They must keep detailed records of the performance of batteries, and of the materials used.

Relieving Others.—They must, in case of emergency, render all assistance in their power to the ..... (Title) and at other times, when not interfering with their regular duties.

Maintenance of Batteries.—They shall follow the special instructions, and the directions furnished by the different manufacturers, for maintaining batteries.

Care, Etc., of Materials.—They shall be responsible for the proper care and use of tools and materials necessary for the efficient performance of their duties, and shall make requisition to the ..... (Title) from time to time, as additional supply becomes necessary.

Changes.—They must not make nor permit any permanent rearrangement or change in wiring or connections without proper authority.

Battery Wells, Etc.—They shall keep all battery wells, chutes, boxes, cupboards and houses neat and clean, and locked when not in use.

Care of Batteries (Protection).—They shall keep batteries at as even a temperature as possible and protected from extreme heat or cold.

Renewing Batteries.—They must not keep more than one cell out of service at one time when renewing track batteries, or more than two cells when renewing main or signal batteries.

Batteries—Jars.—They shall handle jars with care to prevent breaking or disturbing the elements, and keep them clean, bright and free from creeping salts. All cracked or broken jars shall be taken out of service immediately.

Battery Solution.—They must not empty battery solution in streams, on roadbed, ties, bridges, or where the solution may come in contact with wires on top of or under the ground.

Batteries (Jumpers).—They shall use jumpers when removing cells to prevent opening normally closed circuits, except where batteries are connected in multiple.

Scrap.—They shall collect all old scrap zinc, copper and other materials and ship to storekeeper once each month.

Cars, Unloading, Etc.

They (track foremen) shall be responsible for the prompt loading, unloading and forwarding of cars containing roadway material. They shall conform to the Master Car Builders' rules governing the loading of material on cars.

Deportment.

General.—Employees must conduct themselves properly at all times. They must be civil and courteous to fellow-employees and patrons of the road. Employees who are dishonest, vicious, quarrelsome or use profane, vulgar or immoral language will be discharged.

Discharging Men.—They shall employ men as the .... (Title) directs. They must treat employees with consideration, and see that they properly perform their duties. They shall discharge men who are incompetent or neglect their duties, but in no case shall they discharge men without cause. They must keep the required records of the time of their men and of the materials used.

Drainage.

Special attention must be given to the proper drainage of the roadbed for the maintenance of good track. This is essential, and the farther water can be kept away, or the sooner it can be diverted from the roadbed, the better the track will be protected.

Construction.—Ditches shall be constructed in accordance with the standard drawing of the sizes necessary to thoroughly drain the roadbed and afford free flow of all water during heavy rains. The line of the top edges of ditches must be well and neatly formed, and be parallel with and at the standard distance from the rails, except at inlets and outlets, where ditches should diverge from the roadbed to prevent damaging embankments.

Ditches should be drained into natural waterways. At locations where this is impossible or impracticable, special instructions must be obtained from the proper authority previous to starting work.

Washing at Ends of Cuts.—When the roadbed is endangered by water from ditches or other waterways approaching too close thereto, causing washing of the soil, the gullies shall be filled up, and special efforts made to prevent continuance of the wash.

Cross-Drains.—Cross-drains shall be installed where necessary. They shall conform to the standard drawing and be placed at the depths and to the grades required to obtain proper drainage.

Surface Ditches.—Surface water should be intercepted by surface ditches on the upper side of cuts when necessary or practicable.

Road Crossings.—Road crossings shall be drained in accordance with the special instructions given by the proper authority in each particular case.

Wet Cuts, Etc.—When side ditches in wet cuts afford insufficient drainage, drain pipes shall be used. The pipes shall be of the quality and dimensions required and shall be laid, as directed, by the proper authority.

Disposition of Earth.—Material taken from ditches or elsewhere must be deposited on the slopes of embankments, below the ballast, and not be put on the tops or slopes of cuts.

Maintenance, Etc.—The construction of ditches or drains, for public or private use, on lands of the company, must not be permitted except by proper authority.

Adjoining land owners must not be permitted to connect ditches or drains with, or divert water into, the company's ditches or drains without proper authority.

Adjoining land owners must not be allowed to obstruct the company's ditches or drains.

Water must not be diverted through private lands or from its natural channels, along the right-of-way, except by proper authority.

Discussion on Rules and Organization.

Mr. McNab: In regard to this new rule 11, I think this association should not go on record as limiting the range of politeness to be extended by employes of any road. I see here, "Employes must conduct themselves properly at all times. They must be civil and courteous to fellow employes and patrons of the road." It seems to me, if an employe is courteous or civil to a man or a woman, not a patron of the road, they might be induced to become patrons of that road. I think there sho ld be something to take away the limiting of the range of politeness or courtesy. It seems to me it is not right to limit it to the patrons of the road.

C. E. Lindsay (N. Y. C. & H. R.): I quite agree with the views expressed by Mr. McNab. These rules are to be inserted in the manual, and I think they should be expressed in the plainest Anglo-Saxon that we can get. I think that clause might well stop with the word "courteous"—they shall be civil and courteous. I have one other objection, and that is to the opening paragraph, 4, which reads, "employes must exercise care and watchfulness, to prevent injury to them-

selves, other employes and the public, and to prevent damage to property." I think the word "take" would be better than the word "exercise." I think the words "and watchfulness" are redundant and unnecessary. I think the first part is addressed to the employe and the latter part is addressed to the employer. The word "must," in the last line, should be "will"—will discharge—giving warning to the employe that he will be discharged if he violates the rules.

Jos. O. Osgood (C. R. R. of N. J.): Then the next sentence would read, "employes who are dishonest, vicious, quarrelsome, or use profane, vulgar or immoral language will be discharged."

P. C. Newbegin (B. & A.): It would hardly seem to me that we want to go on record that the employes will be discharged if they use profane language. It is best, in my judgment, to have no rules that are not to be enforced.

Azel Ames (U. S. Block Signal & T. C. Board): I do not think it is proper in any rule of a railway to state, "if you do this, you will be discharged." It is assumed that a man will be discharged for non-obedience to the rules, if that non-obedience is flagrant or frequent enough, but I do not think any specific rule should embody in it the threat that if the man does not obey that particular rule he will be discharged.

Mr. McNab: Mr. President, I think the last clause of this rule should not stand. I think it would require unusual perception to determine what is the degree of vulgarity or dishonesty or any other feature connected with these qualifications. I think that any well-regulated railway will see that employes are discharged if they are guilty of that.

A motion to eliminate the last clause of rule 11 was carried.

A motion to insert a clause in rule 4, saying—"when employes are working on double tracks, they should get off of both tracks when trains are approaching"—was defeated.

Mr. Lindsay: I ask if the committee will omit the words "without proper authority" on the first line of rule 10.

The President: That is satisfactory to the committee.

Prof. S. N. Williams (Cornell College): If it is the intention to shorten the rules, might not the words "civil and" be eliminated, so as to make the rule read, "they must be courteous to fellow employes," etc. Or it might be better to have the rule read, as follows: "Employes must conduct themselves properly at all times, and be courteous to fellow employes and patrons of the road," etc.

The President: That is acceptable to the committee.

Mr. McNab: If these rules are to be incorporated in the manual of recommended practice, I think there should be no ambiguity as to the meaning of any word. A man may compare his watch and put it in his pocket, and do nothing more than that. I think the word "verify" would be a better word to use. I ask the committee if they will accept the word "verify" instead of "compare."

The President: That change is acceptable to the committee.

The convention is open to suggestions from the members on the future work of this committee. It is very useful to the committee to know what the wish of the association is with reference to its work, and along what lines it should proceed. It will be found that this committee has done an immense amount of work during the year. It examined the rules of sixty-one railways, and tabulated and compiled the information, which in itself is a large task. These rules were classified under eight different heads, and conclusions were drawn therefrom.

Mr. Osgood: The eight selected represented a very small portion of the rules examined. We found, after making a record of the rules, that there were certain variations, and we then selected a certain number which seemed best to us, and have submitted them as an appendix.

E. F. Wendt (P. & L. E.): I think this committee is working along a line which will result in much good for railways, and the recommendation which they have submitted is certainly one which should be adopted, and the subjects for next year will be along that line. A number of prominent railways have, at the present time, standard books of rules for the government of Maintenance of Way departments, but such books are not in general use. It seems to me that the committee should continue the good work which has been begun, and produce finally a book of standard rules for the Maintenance of Way department, these rules being of general application.

H. A. Lloyd (Erie): In reading over some of the rules, I notice they have entirely different sets of rules governing the track foremen, the bridge and building foremen, and the signal foremen. Since a lot of clauses and paragraphs are applicable to each one, this makes a voluminous book. It seems to me that could be eliminated.

The President: The committee in formulating its work in the preparation of a general book of rules, and wherever it is possible to make a general rule applicable to all employes, it will compile it as a general rule, so as to avoid repetition.

SIGNALING AND INTERLOCKING.

Seven subjects were assigned, as follows:

(1) Revision of Manual;

(2) Continue investigation of outline and description of a complete and uniform signal system suitable for general adoption, conferring with proper committee of the American Railway Association on the subject;

(3) Revise mechanical interlocking specifications presented in Bulletin 108, and include wrought-iron pipe as well as steel;

(4) Review and resubmit electric interlocking specifications, with statement of the results from experience;

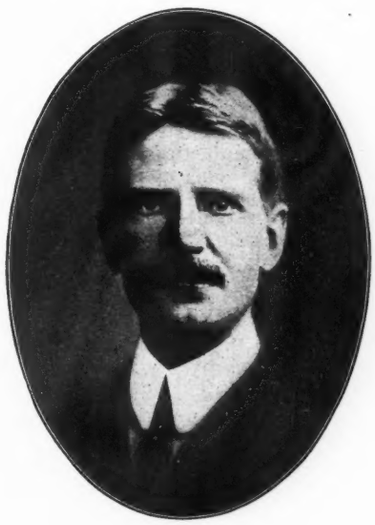
(5) Confer with committee on ties, and make report on the effect of treated and metal ties on track circuits;

(6) Confer with committee on yards and terminals, in regard to capacity of terminal layouts;

(7) Make concise recommendations for next year's work.

The following sub-committees were appointed:

Revision of Manual: Messrs. Ames, Balliet, and Wendt, chairman. Uniform Signal System, Sub-Committee "B": To prepare statement to be submitted to the proper committee of the American Railway Association, Messrs. Stevens and Anthony. Met in Buffalo, April 5, and completed its work. Sub-Committee "J": Elected by the entire committee to represent it when called into further conference by the Committee on Transportation of the American Railway Association, Messrs. Anthony, Clausen, Patenall, Stevens, and Rudd, chairman. It has not been called. Sub-Committee "C": To report on the indications after the Committee on Transportation has made a decision on the points of difference between the majority and minority as brought out at the last annual meeting, Messrs. Baker, Besler, Cable, Causey, Clausen, Harahan, Ingalls, Scott, Temple, and Rudd, chairman. No meetings. Sub-Committee "A," on Aspects: Messrs. Patenall, Peabody, Stevens, Young, and Anthony, chairman. No meetings.



A. H. Rudd

Chairman, Committee on Signaling and Interlocking.

Mechanical and Electrical Interlocking Specifications. Messrs. Anthony, Patenall, Peabody, Stevens, and Mock, chairman. Met at Chicago, November 14, all members present.

Effect of Treated and Metal Ties on Track Circuits: Messrs. Christofferson, Elliott, Eck, Hovey, Mock, Rhea, and Denney, chairman. No meetings held.

Conference with Committee on Yards and Terminals: Messrs. Balliet, Eck, Peabody, Wendt, Young, and Elliott, chairman. One meeting.

Recommendations for Next Year's Work: Messrs. Ames, Clausen, Denney, and Rudd, chairman. One meeting.

Conference with Committee on Track—Special. Messrs. Ames, Anthony, Elliott, Patenall, and Rudd, chairman. Mock

afterward substituted for Rudd, as chairman. Two meetings.

REVISION OF MANUAL.

Specifications for rubber-covered wire were adopted March, 1909, and are in the Manual. New specifications have been accepted by the Railway Signal Association and sent to letter-ballot for approval.

It has been the policy of this association to let the Railway Signal Association work out details of signal appliances and to adopt only after adoption by the Railway Signal Association. The committee, therefore, offers for the reasons set forth in the report this conclusion: "That the revised specifications for mineral matter rubber compound insulated signal wire be adopted by the association and printed in the Manual."

The changes from present specifications are as follows:

Title has been changed by inserting the words "Mineral Matter Rubber Compound," as being indicative of the general character of the insulation this specification was drawn to cover, and which is, with the exception of certain other compounds, the type of insulation generally required.

In Clause 1, Conductors, the words "weld or joint" have been inserted as more fully explaining the requirement that a conductor is desired that is of one piece as coming from the wire-drawing machines.

Clauses 2 and 3, Rubber Insulation, have been changed to eliminate all references to quantities which are given under Clause 17, and the word "Upriver" has been inserted as specifying the quality of rubber desired, there being a number of grades of Para rubber.

Clause 4, Braiding, has been changed to eliminate the taping, which was useful only as a mechanical protection, and, besides being quite expensive, was not deemed necessary.

Clause 5, Acceptance, is new and is required to enable the purchaser to assure himself as far as practicable before the product has been manufactured that a satisfactory compound will be furnished. This clause is as follows.

"Acceptance.—5. The product of those concerns only will be accepted who have satisfied the purchaser that the requirements of this specification will be complied with. The decision as to the quality of the wire furnished and the acceptance of the same shall be made by the purchaser."

Clauses 6 and 7, Tests, are practically the same as in the present specification, while clause 8, in regard to interpreting the result of the chemical analysis of the compound, is new. The necessity for this clause is obvious if an analysis is made of the compound. Clause 8 is as follows:

"8. At the option of the purchaser the wire, after being tested, shall not be shipped from the factory until an analysis of a sample has been made by a chemist chosen by the purchaser, and the results of such analysis, as interpreted by the purchaser shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of this specification."

Clause 9, Physical Test of Copper Conductors, has been changed to eliminate all tests except those of elongation and the simple bending tests, these being ample to insure the desired quality of material.

Clause 10, Conductivity Test of Copper, and clause 11, Test of Tinning, are unchanged, while clause 12, requiring an excess of sulphur in the sodium sulphide solution, has been added, as, without this requirement, the test for tinning is valueless. Clause 12 is as follows:

"12. The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds."

Clause 13, Tests of Braiding, is unchanged.

Clauses 14, 15 and 16, Physical Tests of Rubber Insulation, have been changed to specify the rate at which the sample shall be stretched, that the tensile strength per square inch shall be 1,000 instead of 800 pounds, that the test shall be made on a separate sample from that on which the stretching test is made and that the specific gravity shall be not less than 1.75. The increase in tensile strength is recommended, as, when properly made, a thirty (30) per cent. Para rubber compound will meet this requirement, and a compound which contains less quantity of rubber or is of an inferior grade of rubber cannot so readily be made to meet this requirement.

The specific gravity of the rubber compound is specified with the idea of securing a compound of a certain density, and to make unlikely the use of fillers which have but little body.

Clause 17, Chemical Tests of Rubber Insulation: This clause calls for the thirty (30) per cent. of rubber and seven-tenths (0.7) per cent. of free sulphur which is required by the present specification, but in the other requirements is practically new and calls for the best practice from a chemical standpoint that could be devised. In connection with chemical analysis, these requirements are regarded as of the greatest importance as insuring to a greater extent than any of the other requirements that a compound will be obtained which will contain the desired quantity of rubber and be of a satisfactory chemical combination.

Clause 18, Electrical Tests of Rubber Insulation, is the same as the present specification, the one-third (⅓) increase in insulation resistance thought advisable by the committee having been opposed by the manufacturers and, at their request, any recommendations on the subject have been postponed with a view to giving time for the manufacturers to demonstrate the correctness of the position taken by them.

Clause 19 has been changed to require that the wire will be arranged in coils for testing to permit of an easy inspection, which is not possible when the wire is wound on a reel.

Clauses 20, 21 and 22, specifying the length of the wire and size of coils, are new, and are required owing to the practice now being followed of making a wire continuous from one binding post to the other and eliminating joints.

Clauses 23, 24 and 25, Packing for Shipment, are new, and prescribe the methods to be followed when wire is to be shipped.

CONCLUSIONS.

Specifications for cables, weatherproof wire, etc., are closely related to the question of rubber-covered wire, and the committee, although not specifically instructed to do so by the Board of Direction, submits specifications for the following:

(1) Mineral matter rubber compound insulated aerial braided cables for current of 660 volts or less;

(2) Mineral matter rubber compound insulated, lead-covered, armored, submarine cable for 660 or lower voltage service;

(3) Double-braided weatherproof, hard-drawn, copper line wire;

(4) Double-braided, weatherproof, galvanized, B. B. iron line wire;

(5) Double-braided, weatherproof, hard-drawn, copper clad, steel line wire;

(6) Galvanized E. B. B. iron bond wires;

and offers the conclusions that these specifications be adopted by the association and printed in the Manual. The committee further submits the conclusion that the stranding table given on page 156 of Vol. 10, No. 1, of the 1909 proceedings, be changed, and that the following tables for stranded conductors and for flexible conductors be accepted by the association and printed in the Manual:

STRANDED CONDUCTORS.

Approximate Size, B. & S. Gage.	Number of Strands.	Actual Circular Mils.
2000000	127	2000250
1500000	91	1502592
1000000	91	1003275
900000	91	900900
800000	91	804076
700000	61	698389
600000	61	597861
500000	37	506493
400000	37	400192
350000	37	351722
300000	37	299700
250000	37	248788
0000	19	211470
000	19	167884
00	19	132468
0	19	105450
1	19	84018
2	19	66139
3	7	52274
4	7	41503
5	7	33327
6	7	26047
8	7	16464
9	7	12943
10	7	10374
12	7	6300
14	7	4375
16	7	2527
18-7 No. 26	7	1778
20-7 No. 28	7	1113
21-7 No. 29	7	889
22-7 No. 30	7	700

FLEXIBLE CONDUCTORS.

Approximate Size, B. & S. Gage.	Number of Strands.	Actual Circular Mills.
0000	37	210900
000	37	168572
00	37	133200
0	37	105894
1	37	83472
2	37	66822
3	19	52364
4	19	41971
5	19	33516
6	19	26011
8	19	17011
9	19	12844
10	19	10051
12	19	6498
14	19	3990
16	19	2508
18-7 No. 26	19	1501

The previous table was confined to 7, 19, 37 and 49 stranding wire with sizes of strands B. & S. G., 11 to 33 inclusive.

The committee finds it desirable that a standard form of report on which the results of physical and electrical tests of wire insulation may be shown should be used, and recommends that the sheet be adopted by the association and printed in the Manual:

(Size of Sheet—8½"x13⅞")

WIRE INSPECTION REPORT No.....

.....191....

Manufacturer .....

Location of factory.....Reqn. No.....

Whose order .....Order No.....

GENERAL DESCRIPTION

Test of .....

To be located at.....Working voltage .....

Single conductor: Length....ft. Size....B. & S. Wall....in. Reels....

Length ...ft. Armor....B. & S. Lead sheath ...in. Reels.....

Composition

No. of Cond. Size, B. & S. No. of Strands. Size of Strands. Wall. Cable.

.....

.....

.....

SPECIFICATION REQUIREMENTS.

Voltage volts A. C for .min. Insulation resistance....megs. per mile at 60 deg. F.

Tensile strength of insulation....lbs. per sq. in. Tensile strength of copper.....lbs. per sq. in.

Permanent set of insulation, 20% Conductivity, 98% at 60 deg F

Elongation of insulation, 350%. Pure Para rubber, 30%.

PHYSICAL TESTS.

Conductor.	Insulation.
Elongation.....% in.....inches	Elongation.....% in.....inches
Torsion.....twists in.....inches	Permanent set..% in.....inches
Tensile strength....lbs. per sq. in.	Tensile strength....lbs. per sq. in

CHEMICAL TESTS.

Conductor tinning test Immersed.....times before blackening

Insulation—Pure Para rubber %. Sulphur .%. Dry mineral matter..%

BRAIDING TESTS.

Gain ...% of weight of braid after....hours. Immersion at....deg. F

ELECTRICAL TESTS.

1 Voltage test: Unbraided wire tested....volts A. C. for.....Min.

Remarks .....

2 Conductivity test.....% of Matthiessen's standard at 60 deg. F

3 Insulation resistance test: Temperature. .. deg. F. Constant....Megs.

Time immersed..... Hrs Voltage of cells volts.....

Coil Nos. Length. Defls. Meg. Mile. Coil Nos. Length. Defls. Meg Mile:

.....

.....

.....

.....Inspector

UNIFORM SIGNAL SYSTEM.

On account of the differences of opinion in the committee, its report on this subject was, by vote of the association, referred back to it in March, 1910, with instructions to confer with the proper committee of the American Railway Association. Such conference was held June 8. A Sub-Committee of three was appointed by the committee on transportation to further report to the entire committee, it being understood that their conclusions, when arrived at, would be transmitted to us. To date we have received no word from them.

MECHANICAL AND INTERLOCKING SPECIFICATIONS.

The committee reports that the Railway Signal Association has only this year practically completed the specifications for mechanical interlocking, including wrought-iron pipe and electric interlocking, which are shown in Vol. 7 of its Journal for 1910, and the committee will arrange and report complete specifications on both of these subjects (Nos. 3 and 4) in 1911.

EFFECT OF TREATED TIES AND METAL TIES ON TRACK CIRCUITS.

No meetings were held, as the chairman of the committee on ties advised that that committee would not take up the subject this year, and the committee on wood preservation did not invite the sub-committee to confer with it.

Special Conference with the Committee on Track.

Conferences were held as outlined above, but the entire committee has had no opportunity to pass on this important subject. The committee therefore recommends that if any matters of switch point drilling, spacing of ties, insulation, etc., require consideration after the annual meeting, they be the subject of the joint action by Committees V and X.

The report is signed by A. H. Rudd, Pennsylvania, chairman; L. R. Clausen, C., M. & St. P., vice-chairman; Azel Ames, Train Control Board; C. C. Anthony, Pennsylvania; H. Baker, Q. & C.; H. S. Balliet, N. Y. C. & H. R.; W. G. Besler, C. R. R. of N. J.; W. B. Causey, G. W.; C. A. Christofferson, N. P.; C. E. Denney, L. S. & M. S.; W. J. Eck, Southern; W. H. Elliott, N. Y. C. & H. R.; W. J. Harahan, Erie; M. H. Hovey, Wisconsin Railway Commission; A. S. Ingalls, L. S. & M. S.; J. C. Mock, D. R. T.; F. P. Patenall, B. & O.; J. A Peabody, C. & N. W.; Frank Rhea, General Electric Company; W. B. Scott, Harriman Lines; Thos. S. Stevens, A., T. & S. F.; H. H. Temple, B. & O.; Edwin F. Wendt, P. & L. E.; J. C. Young, U. P.

Discussion on Signals and Interlocking.

Mr. Ames: There is a misprint in clause 12, on page 134, in describing the covering to be placed over the armoring on submarine cables. It says: "Over the armoring a layer of closely woven jute braiding shall be placed." It should read: "Over the armoring a layer of twisted jute roping should be placed."

B. H. Mann (Mo. Pac.): The question of language in the conclusions as recommended by the committee is important. The first specification we adopted was for mineral matter rubber compound insulated signal wire, and that was adopted as being in accordance with the best practice. It seems, though, the mere fact that it was voted to put that in the manual is no reason why we should leave that wording out, for the reason that in the specification under discussion the conclusion reads: "That the specifications for double braided, weatherproof,hard drawn copper line wire presented as prescribing the best practice, be adopted by the association and printed in the manual." There is a doubt, it seems to me, as to whether the committee means that the double braided, weatherprcof, hard drawn copper line wire is the best sort of weatherproofing, or whether they mean this will be specified as the best for the double braided wire. As far as the question of whether the double braided insulation is better than a triple braided insulation, or some other sort of insulation, it does not seem to me that this is the time to take that up, and as far as the adoption of the specification by the Signal Association is concerned, it was put through just as the first conclusion we have adopted, leaving out the words "presented as prescribing the best practice." In that way, we will obviate any possibility of some of the railways inferring that the Maintenance of Way Association has said that the double braided, weatherproof wire is the best for insulation.

Mr. Elliott: The committee has no objection to accepting the suggestion made by Mr. Mann.

Mr. Mann: Is that a typographical error, the use of the BB instead of the "Extra B?"

Mr. Elliott: It should be "BB" in the title, and not "Extra B."

The President: That correction will be made.

Thos. S. Stevens (A. T. & S. F.): I would call attention to the fact that the conclusions are apparently in the wrong place. It is a matter for the secretary to take care of when the report is printed.

The President: This order was submitted by the com-

mittee. It is true that the conclusions should be in another place, and should follow the specifications.

Mr. Elliott: The committee asks to eliminate the word "iron" both in the title of the specification and in the second line, as the revised title, "double braided, weatherproof, galvanized BB line wire," more correctly specifies the material, which is furnished, and which is used for this purpose.

Mr. Mann: It is understood the committee reports for the adoption of the association that the use of BB weatherproof line wire is the best practice, and a specification for BB iron line wire, or double B galvanized line wire, is desirable, but it does not say that the extra "BB" is the best.

Mr. Elliott: The two things I understand Mr. Mann has in mind are the use of the word "iron," and whether the double B wire is to be preferred to the extra BB. The committee has drawn up a specification for BB line wire, and finds that is the quality of wire most used for the purpose. Another specification would be drawn for extra BB line wire, if it is desired to have such a specification. The specification, in its revised form, eliminating the word "iron," covers the material as furnished and produced commercially. It is in order to prevent any confusion or difference between the purchaser and the manufacturer that the word "iron" is eliminated. The committee asks permission to eliminate from the second line of the conclusion regarding galvanized E. B. B. bond wires the words: "which calls for the best practice in the furnishing of this product." The committee also asks to eliminate the word "iron," both in the title of this specification, and in the first line of the conclusion, as the revised title, "galvanized E. B. B. bond wires," correctly specifies material which is furnished and used for bond wires.

C. H. Ewing (A. C. R. R.): I would like to call attention to Subject 2. As I understand it, the subject of uniform signal practice is in about the same condition as at the last meeting, with the exception that it has been referred to the American Railway Association committee. It would be of very particular interest if the committee could advise us if they have had any meetings on this subject, and if they have been able to reconcile any of their ideas.

Mr. Elliott: The committee had a conference with the Transportation Committee of the American Railway Association at Niagara Falls last June, and a full hearing and discussion was had. There was a good deal of interest on both sides. I understand the committee of the American Railway Association, having this matter under consideration, has had three or four meetings, and has about concluded its recommendation or decision. At this time we have not had any report as to what that conclusion would be, and until it is finished this committee does not expect to do any further work or take action on the subject. The committee was dismissed with the thanks of the association.

In introducing the report of the committee on Electricity, Chairman Kittredge read the letter which Mr. Berg, a former president, read to the committee at the time the subject was first discussed.

ELECTRICITY.

The following subjects were assigned:

(1) Clearances: G. A. Harwood, R. D. Coombs, A. O. Cunningham, W. S. Murray, George Gibbs, E. B. Katte.

(2) Transmission lines and crossings: R. D. Coombs, A. O. Cunningham, G. A. Harwood, W. S. Murray.

(3) Insulation: J. A. Peabody, R. D. Coombs, W. S. Murray, E. B. Katte.

(4) Maintenance organization: J. B. Austin, Jr., E. P. Dawley, C. E. Lindsay, E. H. McHenry.

(5) Electrolysis: W. W. Drinker, W. S. Kinnear, J. A. Peabody.

(6) Relation to track structures: C. E. Lindsay, E. P. Dawley, E. H. McHenry, J. B. Austin, Jr.

CLEARANCES.

Third-rail clearance line.—Lines beyond which no part of the third-rail structure shall project.

Equipment clearance lines.—Lines beyond which no part of the equipment shall project. Allowance to be made by equipment manufacturer for new equipment for wear on journals and brasses, on axle collars, on rail, on wheels, compression of springs, sagging of center of car, constructional variations, end play, broken springs, etc.

Third-rail gage.—Distance, measured parallel to plane of top of both running rails, between gage of running rail and center line of third rail.

With the adoption of electric traction by railroads using steam equipment, the question of what would constitute safe clearance lines for locating third-rail structures and overhead working conductors immediately presented itself. Most of the roads using steam equipment constructed their third rail so that it would clear the existing equipment, but it was deemed advisable also to fix a limit so that new equipment should not be built to encroach on the space occupied by third rail. Each road could adopt such equipment clearance lines as would meet its requirements, but this would not prevent complications in regard to interchange of foreign equipment and therefore the American Railway Association appointed a committee to establish recommended clearance lines for both third-rail structures and for equipment.

The study of existing third-rail structures, together with the clearance lines adopted by the American Railway Association, has led the sub-committee to recommend the attached diagram, entitled "Recommended Clearance Lines for Equipment and Third-Rail Structures, submitted by the Committee on Electricity."

Owing to the overhang of equipment passing around curves, it is advisable to change the lines adopted by the American Railway Association so that the limits shown on attached sheet will be applicable in all cases where the radius of curves is 800 ft. or less.

It has been the experience of steam railways operating a portion of their territory by third rail that, in spite of rigid requirements that equipment be not allowed to extend beyond the line of maximum equipment, cars frequently have to be cut out of service in the electrified territory because of heavy loading, defective springs or other reasons causing the equipment to project beyond the limiting lines.

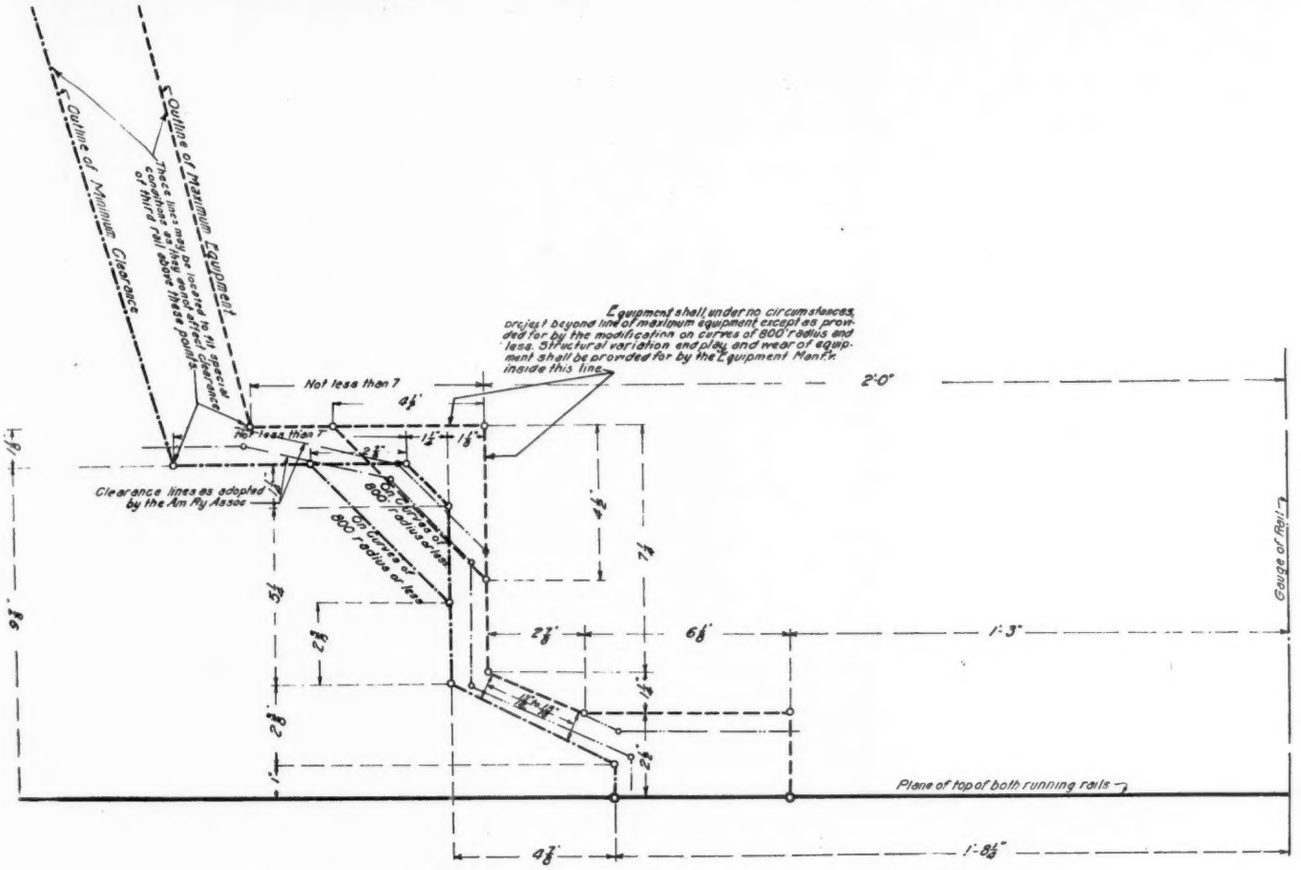
G. W. Kittredge.
Chairman, Committee on Electricity.

Principally on account of this reason it is thought that the distance of one-half inch between the outline of maximum clearance for structures and the outline of maximum equipment is too small, and that if structures and equipment are allowed to approach so close there will be trouble from fouling in the event of adverse conditions. The sub-committee recommends a distance of 1⅛-in. apart for these two vertical and horizontal lines and a distance varying from $\frac{13}{16}$ in. to $\frac{15}{16}$ in. apart on the inclined part of the diagram which takes care of the side inclines at approaches to the curves, and specifies that "equipment shall under no circumstances project beyond line of maximum equipment except as provided for on curves of 800-ft. radius and less. Structural variation, end play and wear of equipment shall be provided for by the equipment manufacturer inside this line.

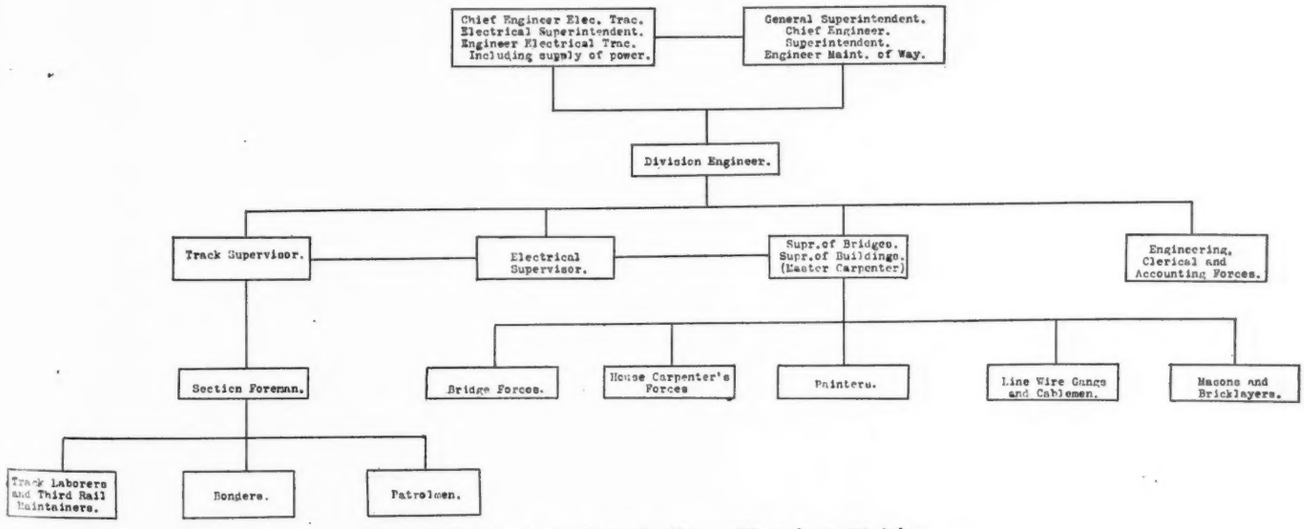
TRANSMISSION LINE CROSSINGS.

The sub-committee has worked in conjunction with the National Electric Light Association and has issued a progress report, which is included in bulletin No. 127. The increase in the number of high-tension transmission lines and the development in the protective regulations enforced by public service corporations and municipal authorities have created a demand for special methods of construction. The attention now given to the subject is due in large part to the presence of occasional lines of relatively high volt-

age. Any voltage over 250 volts with the currents generally used may cause painful, and, under exceptional conditions, fatal injury. It has, therefore, become necessary to consider all phases of the question as well as all voltages, but as the probability of danger to life or property is mainly confined to the immediate vicinity of the power line and particularly to the space over or under the same, the committee has discussed in this report the so-called "crossings" and not the construction of the power line itself. The more common forms of accidents, together with their causes and results, are discussed. The conditions of loading, cradles, grounding, size and material of wires, insulators, pins, clamping devices, insulated wire, and preservative treatment of cross-arms and poles are dwelt upon in this report, which also includes tables giving the properties of the various forms of wire in common use.


Outline of Minimum Clearance
Outline of Maximum Equipment
Trace lines may be located to fit special conditions as long as they do not project beyond these points
Equipment shall under no circumstances project beyond line of maximum equipment except as provided for by the modifications on curves of 800' radius and less. Structural variation and play and wear of equipment shall be provided for by the Equipment Manf'r. inside this line.
Not less than 7
Not less than 7
2'-0"
Clearance lines as adopted by the Am Ry Assoc
On curves of 800' radius or less
On curves of 800' radius or less
Gauge of Rail
Plane of top of both running rails
1'-3"
1'-8½"

Recommended Clearance Lines for Equipment and Third-Rail Structures.



Proposed Standard Organization; Electrical Division.

MAINTENANCE ORGANIZATION.

In connection with the sub-committee on relations to track structures, this sub-committee sent out a circular asking for information concerning the effect of electric traction on the maintenance organization and what changes were made necessary in the track standards; also what had been the effect of electric equipment on the track and steel structures. From a study of the organizations now existing the sub-committee believes that the officer in general charge of maintenance of way of a railway operated by steam or electricity, or both, is, or should be, fully equipped to superintend the maintenance of the various appliances that have been introduced in connection with electrical installation, but should have on his staff an electrical engineer, or be able to consult with one.

Similarly, the division officer in charge of maintenance

of way should have on his staff a man with sufficient knowledge of electricity peculiar to the installation that will enable him to inspect the work of maintenance performed by the department.

The maintenance of towers or bridges for the support of transmission lines being work of no different nature from that actually performed by the bridge men, there is no reason why it cannot be done under the supervision of the head of the bridges and building forces. The maintenance of the buildings occupied as power houses, sub-stations, battery houses, circuit-breaker houses and cable terminals, is such as is usually done by the building department, and there is no reason for this work being done by any other or by any special department, the only unusual condition being the presence, in some cases, of transmission lines carrying electric current of high voltage, and there is no difficulty in educating men erecting, repairing, painting, etc., around these transmission wires to take the necessary precautions for their safety and for preventing the interruption of the service. The maintenance of aerial cables, wires, suspension bridges of the catenary type composed of wires involves no special knowledge or training that the man in charge of the maintenance of bridges and buildings should not possess. The only care being necessary is to educate the traction linemen actually employed in the work in protecting themselves against personal injuries from high-tension currents and taking the necessary precautions to avoid interruption to the service. This applies with equal force to roads having the third-rail type of contact or the overhead type of contact.

The work of maintaining third rail and appurtenances and track bonds is so closely associated with the work of maintaining track that the section foreman is the logical and proper man to be in charge of all such work on any particular section. The bonds, being usually of the concealed type, necessitate the removal of the joints before they can be inspected or repaired; the third rail is usually supported on the track structure and is in intimate relation with it, so that repairs to the one usually involves repairs to the other, demanding the presence of the section forces, and therefore the section foreman should be the man in control. These remarks apply with equal force to the removing of snow, ice or other obstructions. In yards and at other congested points where there is a number of tracks the work of bond maintenance may be of sufficient amount to warrant having bonders on the section forces, or may be sufficiently great to warrant the organization of an extra gang of bonders, working under an extra gang foreman under the control of the supervisor of track, or, in the event of stretches of territory where the work of bond maintenance would not warrant the employment of a man on each section for that purpose, it could be cared for by bonders under the direct supervision of the supervisor of track, these men to work under the immediate supervision of the section foreman while on his territory.

The work of the patrolman, which, on some roads, has been devoted exclusively to the inspection and minor repair of third rail and its appurtenances, is closely associated with that of the trackwalker, and there is no reason why one man could not perform the duties of both and also give such attention as may be necessary to the mechanical inspection of aerial wires and cables, territories being so arranged as to be reasonably within the physical capacity of the patrolman and so as to give inspection sufficiently often to safeguard traffic and avoid delay thereto.

The electrical supervisor above mentioned who reports to the division officer in charge of maintenance is understood to exercise general supervision over all the electrical work done by the supervisor of track and the officer in charge of bridges and buildings, with a view to securing adherence to standards and proper methods of work, principally from an electrical standpoint.

The committee wishes to emphasize one important feature of this proposed organization, namely, the fact that the classification of expense accounts as established by the Interstate Commerce Commission and by various state commissions places in the maintenance of way the expense of maintenance of transmission lines, contact lines, power houses, etc., so that it seems to be exceedingly logical that the actual supervision of the work of maintenance should be done under the supervision of the maintenance of way organization.

In conclusion the sub-committee recommends:

(1) The adoption of the definitions given for Electrical Supervisor, Bonders, Traction Linemen and Patrolmen.

(2) That the work of maintenance should be done as far as possible by the existing maintenance of way organizations, with such modifications as may be necessary for the special work involved in the electrification.

(3) That a Maintenance of Way Organization, as shown on exhibit attached, will be productive of efficient results.

(4) That these recommendations be printed in the Manual.

RELATION TO TRACK STRUCTURES.

Bond.—A metallic means for connecting two rails to permit of passage of electric current.

Cable.—A rope composed of wires for the transmission of electricity.

As the sub-committee has not received reports from many of the roads on which electric propulsion has been introduced, it does not feel warranted in drawing conclusions at this time.

Recommendations.—(1) That the definition of bond and cable be adopted. (2) That the committee continue its investigations along the lines outlined in the circular of inquiry.

CONCLUSIONS OF THE WHOLE COMMITTEE.

Third-Rail Clearance Lines.—Lines beyond which no part of the third-rail structure shall project.

Equipment Clearance Lines.—Lines beyond which no part of the equipment shall project. Allowance to be made by equipment manufacturer for new equipment for wear on journals and brasses, on axle collars, on rail, on wheels, compression of springs, sagging of center of car, constructional variations, end play, broken springs, etc.

Third-Rail Gage.—Distance, measured parallel to plane of top of both running rails, between gage of running rail and center line of third rail.

Electrical Supervisor.—An officer on the division staff qualified to supervise the maintenance of the electrical transmission and working conductors outside of the power station.

Bonders.—Employes qualified to maintain rail and other bonds and their appurtenances for all railroad voltages.

Traction Linemen.—Employes qualified to maintain wires and cables and their appurtenances.

Patrolmen.—Employes qualified to inspect and make minor repairs to track and third-rail structures, cables and wires, and to use hand signals for the protection of trains.

Bond.—A metallic means for connecting two rails to permit of passage of electric current.

Cable.—A rope composed of wires for the transmission of electricity.

(2) The lines shown on diagram B as third-rail clearance lines.

(3) The lines shown on diagram B as equipment clearance lines.

(4) The principle that electric maintenance should, as far as possible, be performed by existing maintenance of way organization, with such modifications as may be necessary.

(5) A maintenance of way organization, shown on diagram A, will be productive of efficient results.

The report is signed by George W. Kittredge, chairman.

Discussion on Electricity.

Mr. Kittredge: I would like to make a few corrections. Under the heading, "definitions," in the conclusions of the whole committee, third rail gage should be the distance between the gage of the running rail and the gage of the third rail, instead of the center line of the third rail. In the definition of "bonders" the last four words, "for all railroad voltages," should be omitted. Those four words properly belong to the next paragraph, which should read: "Employees qualified to maintain wires and cables, and their appurtenances for all railroad voltages." The committee desires to remove from the conclusions recommended for adoption subdivisions 2 and 3; the lines shown on Diagram B as third rail clearances, and the lines shown on Diagram B, as equipment clearance lines, and consider these as reports of progress. It is expected that before the next meeting we can agree with other railway associations on lines that will be satisfactory to all and we think it would be better to have our recommendation of them postponed until the next meeting.

The recommendations of the committee under the head of "definitions" were adopted.

J. C. Mock (Detroit River Tunnel Co.): I should like a little explanation of the definition of third-rail gage. We have been accustomed to use the center line of the third rail. I would like to have explained just what the gage line would be.

Geo. Gibbs (P. T. & T. R.): In trying to define any third rail gage, the clearing point of the third rail, we are working on very close clearance and we are trying to harmonize close dimensions on both sides. The center of the third rail does not fix any point. The third rail may be two or four inches wide, making a difference of an inch, and that is very important.

Robt. Trimble (Penna.): I suggest that the word "line" be omitted, if you are going to change the word "center gage."

Mr. Ktitredge: The committee will accept that amendment.

C. C. Anthony (P. R. R.): Mr. President, as this is a definition of third rail gage and it evidently means the gage of the distance between two lines, should not the word "line" appear in both cases in the body of the definition, "between the gage line of the running rail and the gage line of the third rail"? And if that is submitted, will it not then be necessary to define the gage line of the third rail?

Mr. Lindsay: I think it will be necessary to adopt the same measuring point on the third rail as on the running rail. The gage is measured at a point one-half inch below the top of the running rail, and that same distance should be adopted on the third rail.

E. B. Katte (N. Y. C.): Because of the very wide difference in the cross section of the third rail, it would not be a very definite line. It would seem to me it should be the distance between the perpendicular line of the third rail and the gage of the running rail.

Mr. Katte: We are interested in a question of clearance, and what we want to know is the space between the vertical plan of the third rail, and the gage line of the running rail. "Gage," I think, is generally understood as being the distance between the verticals.

Mr. Anthony: I would like to emphasize the fact that this definition, as it stands, is not correct in that third rail gage is defined by third rail gage. I cannot see why in the world lines should not appear twice in the gage definition—"gage line of the running rail and the gage line of the third rail."

Mr. Gibbs: Mr. Anthony is entirely correct, but the gage of the track rail is a well-known term, and as we are simply trying to find the measurement between that point and a similar point on the third rail, it will be better defined if we use that term than by any other explanation we could give.

W. M. Camp (Ry. & Eng. Rev.): This is a definition which should be considered pretty carefully. In the gage of track rails, we have the rails right side up, but with the third rail, we may have that rail standing with the head upward or with the head downward. Do we want the third rail gage for the purpose of clearance or is it desired for the purpose of meeting the requirements of the reach of the collector shoe on the car? If the latter is the requirement, then the center of the third rail would be a more desirable point to measure to than the gage line of the head. If the rail is inverted with the head downward, the measurement to the gage side of that head for gage purposes might not be satisfactory, because the base of the rail might be nearer the gage line of the running rail. I would like to ask the chairman what the purpose of this gage is. Is it to determine clearance or to determine the proper distance to the rail for determining the reach of the collector shoe?

Mr. Kittredge: For both purposes. It is essential for one, and essential for the other, too.

Mr. Kittredge: The committee is willing to accept Mr. Anthony's amendment by inserting the word "line" after the word gage, in each case, in the last line of the paragraph.

H. Baldwin (C. C. C. & St. L.): In trying to establish clearance distance why not omit the word "gage" in the second instance? The distance between the gage line of the running rail and the third rail is the question.

Mr. Gibbs: The important point of the third rail is the side of the head which establishes the point where we must place the approach blocks for the side of the inclines on which the shoe will ride it. The top corner and side on the contact part of the rail is the important point, and we must fix that. The other parts will take care of themselves.

Mr. Mock: The distance from the standard rail to the gage line of third rail is not fixed by this definition, because of the great differences of rail sections. It seems to me the line should be fixed, and then whatever the form of rail, it must be placed in a certain relation to that.

Mr. Kittredge: There should not be a confusion between the gage line and the clearance line. The gage line of the third rail is not necessarily any clearance line, either for equipment or structures.

Mr. Kenly: I understand the thing to be determined is the third rail clearance lines, not the location of the third rail itself. Then the next thing is to get the third rail location, so that your contact shoe will reach it, and if the center line of that third rail is measured from your gage line, will not that fix the whole thing?

Mr. Lindsay: I think one great difficulty with the adoption of the center line as the measuring point is the fact that rails are not all symmetrical around the center lines, and where you have an unsymmetrical section, it is difficult to say what is the center line. I think it would be well to drop the track gage as a point from which to measure to the running rail, but take the center of the track, and say that no part of the running rail above a certain level shall be nearer the center of the track than a certain distance.

Mr. Kittredge: It occurs to me that that is fixing the third rail clearances, and not defining third rail gage. This definition is for the third rail gage, and not clearances.

Mr. Camp: I don't believe we can make this definition suit both clearances and gage. I understand Mr. Kittredge to say that the rail might be at the gage and still not have the desired clearance. To establish clearances, you must measure to the nearest part of that third rail. But if you are going to get it in order to determine the length of the reach of the shoe, then you must use that part of it which comes in contact with the shoe. Unless something more is added, I don't see how the definitions can specify both clearance and gage.

Mr. Trimble: Isn't the point that Mr. Camp raises covered by the definition of third rail clearance lines?

L. S. Rose (C. C. C. & St. L.): As I understand it, definition 1 establishes two lines, one on each side of the track. The third rail would have to be placed within these two lines. The gage line of this third rail will be located according to the third definition.

Mr. Ewing: The matter to be determined is not a standard gage distance. That varies according to the type of rail used. The purpose of this definition is simply to indicate where measurements shall be taken; and perhaps the best measurement can be secured from the center of the rail rather than from the side.

Mr. Gibbs: It is difficult to explain to the association, without diagrams, just what we are after. In laying down a third rail on a track, the shoe must be so adjusted that it has sufficient contact area on the top of the rail or on the bottom of it. That generally means that the third rail shall lap over about two-thirds of the head, if the head is about two and a half inches wide. A very important consideration is getting that shoe, which is hanging down off of the rail, up on to the rail when it approaches.

A motion to adopt the definition was carried.

Mr. Porter: In the second definition, "allowance to be" starts the second sentence. Shouldn't that be "shall be" or "will be?"

The President: The committee recommends the words "must be" instead of "to be."

Mr. Kittredge: In the fourth definition, the committee would add, "and sub-stations."

The other definitions were accepted as submitted.

Mr. McNab: It seems to me that the word "existing" in paragraph 4 is not necessary. What is existing today may not be existing six or twelve months from now. I think you will cover the same ground if you leave the word "existing" out.

Mr. Kittredge: I do not see that it is essential that that word be taken out. As a rule the installation of electrical operation comes about after the steam operation. It is not necessary that it should, but in the majority of cases it does, and the idea expressed by this is that a new organization for maintenance is not essential. Any existing organization can be developed and expanded and brought up to the point where it can take care of electrical organization as much as steam organization.

A motion to leave out the word "existing" in this paragraph was defeated.

Mr. Kittredge: I suppose there is more opportunity for discussion on conclusion 5 than on any other conclusion that this committee has recommended. The plan that has been outlined in this paragraph is a plan of organization. We don't say that it is the only plan, or the best plan. It is a plan which will bring efficient results. The conditions which exist on various railways are very different. It may be necessary to enlarge certain parts of the organization on

some roads and on others the duties of three or four persons named here, might be given to one person.

The President: If there is no objection, this will be accepted as information.

Mr. J. B. Austin, Jr. (L. I. R. R.): We have been talking about third rail organization and not about signal organization. If you want to bring the signal engineer under the electrical engineer, that is a matter for each road to settle for itself.

Mr. Lindsay: The committee purposely eliminated the signal side of the question from its outline of organization. Signaling is, in itself, a great and important specialty, and there is nothing in this outline of organization that interferes in any way with the introduction of the electrical system.

Mr. Mann: In connection with the definition of the electrical supervisor, his duties, are not clear to me. He is qualified to do certain things, but to have those things done, he must go to a co-ordinate officer, the master car builder. He is in a sense responsible under this title of electrical supervisor, but if he wants a wire repaired, and the men who repair the wires are repairing a building, is it necessary for him to go to a division engineer and ask that the master carpenter be instructed to do the work?

Mr. Kittredge: In the definition of electrical supervisor, we have made no attempt to describe his duties. We describe the man. An electrical supervisor on one road may confine his attention to one or two things. On another road he may be a very busy man and not have the title of electrical supervisor, and still be the electrical supervisor.

The committee was excused with the thanks of the association.

BRINE DRIPPINGS FROM REFRIGERATOR CARS.

The Master Car Builders' Association has experimented with a plan which provides that the brine drippings from refrigerator cars be retained in the tanks inside of the cars between icing stations and the tanks emptied at icing stations or points where cars are usually re-iced. Some tests had been made, but they were not satisfactory and were to be continued under extremely high temperature conditions. Accordingly, in August, 1909, the committee conducted an eight-hour day test at the Armour Car Line shops, Chicago. The tests extended from August 4 to

J. C. Mock.

Chairman, Committee on Brine Drippings From Refrigerator Cars.

August 11, inclusive. The maximum temperature was 94 degrees, between four and five o'clock, August 8. The committee states the tests justify them in making the following recommendations:

"1. All salt-water drippings should be retained in the ice tanks and drained off only at icing stations.

"2. The total capacity of drain openings should not exceed the capacity of traps, and the capacity of drains and traps should be sufficient to release all drippings within the time limit of icing the train.

"3. The mechanism adopted for handling drain valves should be simple and positive, and so designed as to insure closing the valves before hatch plugs can be returned to their places.

"4. Salt drippings should be conducted from ice tanks through the drain valves above described and thence to the outside of cars through the regular traps and drain pipes.

"The packing companies have co-operated with your committee in their investigation, and have expressed their willingness to put into effect the practice recommended by your committee, if these recommendations meet with the approval of the Master Car Builders' Association."

As the above report was approved by the Master Car Builders' Association, June, 1910, your committee is of the opinion that the present status of the subject does not require submitting of further data, showing the damage caused to railroad property because of the present practice, and concludes:

(1) That this association should request the American Railway Association to approve the recommendations of the Master Car Builders' Association as satisfactory.

(2) That this association should request the maintenance of way departments to provide the facilities needed to dispose of the brine drained from cars at the re-icing stations.

The report was signed by: J. C. Mock, chairman; C. H. Cartlidge, C. B. Hoyt.

Discussion on Brine Drippings from Refrigerator Cars.

The President: I think the thanks of this association and of the railways are due to the M. C. B. association committee, and the committee of this association for finally reaching a conclusion on this matter.

R. G. Kenly (M. & St. L.): I think if we pass this report up to the American Railway Association as having been adopted by this association, we have done our duty and we should not attempt to influence that association by telling them what to do.

The President: The M. C. B. association has already submitted a report to the American Railway Association and it seems to the Chair that it would be proper for us to request prompt action in the matter in order that we may get relief from this burden. The committee of the M. C. B. association did most of the work and they are entitled to the credit for it. It seems to the Chair that the conclusions of the committee are very well taken in the matter.

The report was adopted and the committee discharged with the thanks of the association.

YARDS AND TERMINALS.

The subjects assigned were:

(1) Consider revision of Manual.

(2) Development of mechanical handling as a means of promoting rapidity and economy in the handling of freight.

(3) Submit typical track layout for passenger terminal of medium size, both dead-end and through, and analyze graphically the train capacity of the layout, conferring with Committee on Signals and Interlocking.

(4) Make concise recommendation for next year's work.

REVISION OF MANUAL.

Minor changes in wording only were made.

MECHANICAL HANDLING OF FREIGHT.

Such developments as have been made relate almost exclusively to the handling of cargo at steamship piers in ocean and inland ports. Nothing appears to have been done in the application of mechanical apparatus to ordinary freighthouse work. The cost of freight handling at terminals, however, is entirely out of proportion to the low cost of transportation in modern railway service, and there are possibilities of considerably reducing this terminal cost by the introduction of mechanical appliances.

DESIGN OF PASSENGER TERMINALS OF MEDIUM SIZE.

This subject has been treated as a continuation or supplement to our report on the subject of passenger terminals in the tenth annual report. Typical track layouts are submitted for both dead-end and through stations that we believe to be susceptible (in their main features) of quite general application. In the design and construction of terminal facilities the object should be to provide such arrangement of tracks as will permit the greatest freedom of movement with the least interference, to the end that incoming and outgoing trains may be handled without serious interruption or delay. In this way will be secured the maximum efficiency of tracks and facilities and the minimum expenditure for installation.

In the operation of terminal stations many, and in some cases most, of the trains handled have to be hauled out of the station after they are unloaded, and placed in a car-cleaning yard. Unless the facilities are ample, they must be moved again after cleaning, and placed on storage tracks. From the storage tracks they are shifted in proper order and placed on a track in the station for outward movement.

If it is necessary at any time to provide for trains arriving or departing (or both) in rapid succession it is very important that the track layout be so arranged that the inbound and the outbound movements will not conflict to any great extent. This will make it possible not only to permit trains in many cases to enter stations at the same time that other trains are departing, but also to fill vacant tracks in the least possible time after outgoing trains have left them. This, in turn, will secure maximum efficiency and will reduce to a minimum the number of tracks in a station to properly handle the business.

The train capacity of tracks depends largely on the facilities provided for rapid handling of the baggage and express matter that is loaded and unloaded while trains are standing at station platform. It follows, therefore, that in order to handle the largest number of heavy trains within a given time these facilities must be the best that conditions will permit, and, if possible, such arrangements should be made as will eliminate interference with the movement of passengers. To this end it is suggested that where it is possible

F. S. Stevens.
Chairman, Committee on Yards and Terminals.

to do so, baggage and express should be received, delivered and handled below the train floor and raised and lowered by elevators located near the baggage and express cars. This will avoid trucking long distances on platforms used by passengers, to the great discomfort of all concerned and the loss of much valuable time.

There is a very wide variation in the time required to load and unload passengers, baggage and express at stations, depending largely on the character and volume of the business handled by different trains and the facilities provided to insure rapid movement. As a rule the passengers can be loaded on long-distance trains in much less time than is required to handle the baggage and express, but with the short distance and suburban trains (on account of the comparatively small amount of baggage and express to be handled) the conditions may be reversed. In any case it is evident that to secure the greatest efficiency in handling a passenger terminal the time required to load passengers and ordinary baggage and do necessary shifting must be considered as the time interval between the departure of trains on any tracks. Therefore, the express, theatrical and other extra heavy baggage should be loaded prior to making up and placing such trains at the passenger platforms.

The operating officers in charge of the large number of stations covered by the investigations place widely divergent estimates of maximum capacity of station tracks, ranging from 2 to 12 trains that could be handled on one track, with an average of 6.5 trains per hour. These figures no doubt represent a very close approximation to the very best results that could be accomplished for a period of time not exceeding one hour and only after preparation had been made, and therefore do not indicate results that could be expected if a continuous performance were required. At the same stations we find that the actual performance is from 2 to 8 trains, with an average of 4.1 trains handled on one track during the busiest hour. It follows, therefore, that under average existing conditions the actual performance during busiest hours is approximately 4 trains per hour on busiest tracks and that a maximum average of 6.5 trains per hour could be accomplished on some tracks. It is to be noted, however, that the stations at which high estimates of efficiency are made either have through tracks or do a large suburban business with light trains.

If, however, facilities can be provided that will permit continuous and rapid handling of baggage and express without interference with the movements of passengers, it is believed that results approximating the best estimates can be maintained for much longer periods of time, and that the average of 6.5 trains per hour is well within the limit of efficiency that can be secured. But to do this it is conceded that the station, the track layout and all facilities must be designed in harmony and with the principal object of saving time in handling, and thereby securing results that would ordinarily require a larger installation. With this object in view, we have considered the subject of track layouts at terminal passenger stations, both dead-end and through, and present for your consideration diagrams showing typical layouts embodying and illustrating the suggestions submitted.

Statistics have been gathered showing the general characteristics of 26 passenger terminals of medium size located in cities in this country, and this information has been tabulated in the accompanying tables. From these it appears that a number of stations at important points are now working close to the limit of their capacity and are showing very creditable efficiency as to operation. But as they are being worked beyond the limit for which they were designed, it is reasonable to suppose that the cost of operation is excessive and that, therefore, some rearrangements and improvements would be advantageous, to save time and reduce cost of handling.

In the diagram representing a dead-end station with eight platform tracks, the double-track arrangement at the entrance is preserved to the greatest possible extent, so that the use of station or platform tracks may be made practically continuous. Results are thereby secured closely approximate to the best that could be secured in a station with through tracks and the same length of platforms. It is suggested that where large numbers of passengers arrive in quick succession (as in the case of suburban traffic), full consideration should be given to the question of providing the passages for egress with inclined floors instead of stairs, with the object of increasing capacity and preventing congestion. It is recommended that the grade or fall of such sloping floors be not greater than one in ten (or 10 per cent.), and that all such floors be kept rough at all times, so that slipping may be avoided.

At stations of either type the time required to place a train on a station track, load it, and clear the track for another train is the minimum time interval between departures of trains from any one track. Therefore, to secure maximum efficiency the track layout must permit operation practically without interference, as in stations with through tracks, and baggage and express handling must not retard the movement of trains beyond the time needed to properly handle the passengers. In regard to the track layout for a through station, it will be noted that the location is shown at a junction of two double-track roads. A separate station platform is provided for the movement in each direction. All trains making the station stop must be switched from the main track to one side or the other of one of these platforms, thus clearing the main line while the stop is being made. In some station plans a middle platform separates the two pairs of tracks, but it is the opinion of the Committee that it is unnecessary to switch trains across one of the through tracks (as with a three-platform plan). Therefore, the double station or double platform plan was adopted, the two main tracks being continuous and on their proper line through the station.

It will be noted also that a station of this kind has almost unlimited capacity, and, therefore, there is comparatively little necessity for much additional trackage. The platforms being of ample size, four ordinary trains can stand at the platform at one time. As these platforms are approached from the bottom, and the baggage and express

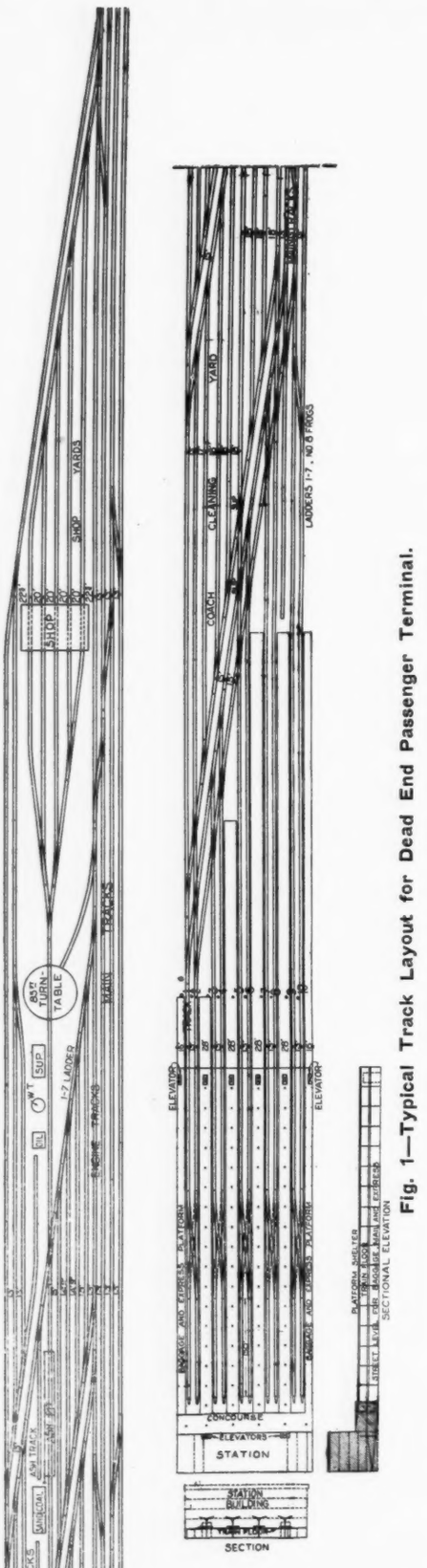


Fig. 1—Typical Track Layout for Dead End Passenger Terminal.

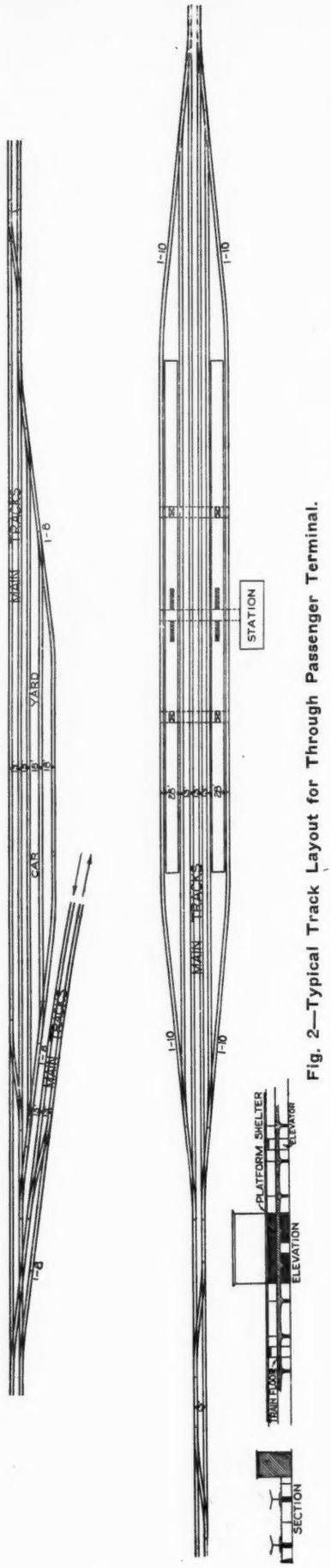


Fig. 2—Typical Track Layout for Through Passenger Terminal.

are handled by elevators, there would be very little interference and the station would be found to have very great capacity.

CONCLUSIONS.

(1) To avoid excessive cost in providing passenger terminal facilities largely in excess of ordinary requirements, it is imperative that provision be made for economical, efficient and practically continuous operation of the terminal during the periods of greatest activity which may reasonably be expected within a period of, say, ten years. To this end the track layout must be designed to permit incoming and outgoing movements to be made at the same time, without interference, as far as it is possible to arrange this.

(2) At passenger terminals where large quantities of baggage and express must be handled, and it does not appear desirable or expedient to provide intermediate platforms to be used exclusively for this service, it is recommended that (where conditions permit), baggage and ex-

FACILITIES AND TRAFFIC AT PASSENGER TERMINALS.

SUMMARY OF TERMINAL DATA.

	STATION.	LOCATION.	TYPE: Through.	TYPE: Headhouse.	TYPE: Over Tracks.	STATION BLD'G.: At End of Tracks.	STATION BLD'G.: Side of Tracks.	GRADE OF TRACKS.: At Streets.	GRADE OF TRACKS.: Over Streets.	GRADE OF TRACKS.: Under Streets.	Through Trains Daily.	Trains Originating.	Trains Terminating.	No. of Trains Handled During Busiest Hour.	No. of Trains Handled on One Track During Busiest Hour.	Est. No. of Trains that Could Be Handled During Busiest Hour.	Est. No. of Trains that Could Be Handled on One Track During Busiest Hour.	Number and Spacing of Tracks.	Number and Width of Platforms.	Length of Platforms.	Height Above Top of Rail.	Are Tracks on Tangent or Curve.	Are Switches Interlocked.
1	Dearborn...	Chicago, Ill.....		*			*			*	0	53	55	14	3	17	3	10 (see Plan)..	See Plan.....	670'.....	6 "	Tangent.....	No.
2	D. L. & W..	Hoboken, N. J....		*		*				*	0	127	118	29	5	54	8	14-13'0" C.-C..	8-20'; 1-17'....	700'.....	6 "	Tangent.....	Yes
3	Erie.....	JerseyCity, N. J.		*		*				*	0	123	126	28	8	33	12	10-15'0" C.-C..	5-15'.....	650'-700'.....	2 "	Tangent.....	Yes
4	Long Isl'd..	Long Island, N.Y		*		*				*	0	135	134	60	5	65	12	24-24'-0" C.-C..	9-14'.....	760'.....	9 "	Tangent.....	Yes
5	Union.....	New Orleans, La..		*		*				*	0	11	11	6	2	12	3	4-24'-0" C.-C...	2-17'.....	704'.....	7 "	Tangent.....	Yes
6	Union.....	Cincinnati, O.....		*		*				*	0	69	67	28	4	30	5	8.....	4-13' & 15'...	1-600'; 3-650'..	10 "	Tangent.....	No.
7	Union.....	Louisville, Ky....		*		*			*		6	24	24	14	3	32	12	6-26'&20'C.-C.	3-17'; 2-11'....	450'-600'.....	6 "	Tangent.....	No.
8	Union.....	Savannah, Ga.....		*		*			*		10	8	8					9-14'to25iC-C.	4-15'; 3-10'....	600'.....	7 "	Tangent.....	Yes
9	Union	Columbus, Ohio..	*			*				*	25	34	35	19	4	19	5	8-11'-0" C.-C..	1-11'; 3-17'....	2-678'; 2-774'..	8 "	Tangent.....a.....	No.
10	B. & O.....	Philadelphia. Pa..	*			*				*	20	14	14	6	3	12	4	6-12'&13'C.-C	2-23'; 1-12'....	700'..	0 "	Tangent.....	Yes
11	B. & O.....	Baltimore, Md....	*			*				*	26	12	6	8	6	12	6	5-12' C.-C....	Shed Area....	426'.....	0 "	Tangent.....	Yes
12	B. & O.....	Baltimore, Md....	*			*				*	37	20	25	6	2	12	3	7-12'&50'C.-C.	3-15'.....	610'.....	15 "	Tangent.....	Yes
13	Union.....	Peoria, Ill.....	*			*				*	0	43	39	14	4	78	12	7.....	1-18';3-12';1-6'.	480'.....	0 "	Tangent.....	No.
14	Union.....	Troy, N. Y.....	*			*				*	57	24	20	14	7	25	10	7-12' C.-C.....	4-12'.....	3-400'; 1-310'.	10 "	Tangent.....	Yes
15	Union.....	Albany, N. Y.....	*			*				*	88	35	34	17	6	17	6	8.....	3-28'; 1-27'....	650'-850'.....	6 "	Tangent.....	Yes
16	P. & R. Ry	Reading, Pa.....	*			*			*		32	14	14	12	3	30	5	.....	1-20'; 2-15'....	1100'.....	8 "	Tangent.....	Yes
17	Penna. R. R.	Harrisburg, Pa...	*			*			*		55	47	45	8	5	30	6	8-12' C. C.....	5-37'-22'.....	765'-860'.....	7 "	Tangent.....	Yes
18	Union.....	Birmingham, Ala.	*			*				*	6	20	20					10-12' C. C....	5-19½'.....	3-620'; 2-770'..	8 "	Tangent.....	Yes
19	C.M.& St.P	Milwaukee, Wis...	*			*				*	22	30	32	12	3	20	6	5-13'&20'C.-C.	Shed Area....	1000'—Max..	0 "	Tangent.....	No.
20	Union.....	Minneapolis,Minn.	*			*				*	44	30	30	16	2	30	2	6-26' C. C.....	Shed Area....	1200'.....	0 "	Tangent.....	No.
21	Union.....	Indianapolis,Ind..	*			*				*	46	42	40	30	4	37	5	8.....	Shed Area....	.....	0 "	Tangent.....	.....
22	Union.....	Toledo,Ohio.....	*	*		*				*	43	39	40					13-12' C.-C....	3-26'.....	.....	0 "	Tangent & Curve.	No.
23	Union.....	Nashville,Tenn...	*	*	*	*				*	10	26	26	11	2	15	4	10-20'&28'C-C	5-20'. 4-11'....	550'-750'.....	9½"	Tangent.....	Yes
24	Union.....	Richmond, Va....	*	*		*				*	10	7	7					9-12'; 23'&13'.	2-8'; 5-14½'....	650'-1248'.....	.....	Tangent.....	Yes
25	Union.....	St. Paul, Minn....	*	*		*		*			92	46	46	42	5	42	5	14-26'&13'C-C	8-16'.....	800'.....	12 "	Tangent.....	No
26	Union.....	Seattle, Wash.....	*	*		*				*	6	35	36					11-12' C.-C....	4-18'.....	200'.....	0 "	Tangent.....	No.

SUMMARY OF TERMINAL DATA.—Continued.

	STATION.	LOCATION.	Method of Making Up and Breaking Up of Trains.	Are Engines Changed on Through Trains.	Are Cars Added or Dropped, and Why.	Special Arrangements For Handling Suburban Traffic.	Method of Handling Express and Baggage.	System of Communication From Dispatcher To Train Conductor.	Distance To Engine House.	Distance To Car Storage Yard.	If Union Station. What Is System of Handling
1	Dearborn....	Chicago, Ill.....	Switch Engines..	No.	.....	None...	Trucks.....	None.....	5m.....	5.6m.....	Own'g Co. handles
2	D. L. & W...	Hoboken, N. J....	Sw.Eng.&Gravit	No.	.....	None...	Trucks & Cars...	Thru Sta. Master..	1800'....	600'.....	Not.
3	Erie.....	Jersey City, N. J..	Sw. &Road Engs	No.	.....	None...	Trucks.....	Semaphores.....	800'.....	700'-4500'.	Not.
4	Long Island..	Long Island, N. Y.	Sw.&RoadEng's.	No.	.....	None...	Sw.Eng.&Trucks	Thru Sta. Master..	½m.....	½m.....	Not.
5	Union.....	New Orleans, La...	.....	No.	.....	None...	.....	Thru DispatchOff.	.....	.....	Not.
6	Union.....	Cincinnati, Ohio...	.....	No.	.....	.....	Trucks.....	Telegraph.....	.....	.....	Sep. sta. empl'ees.
7	Union.....	Louisville, Ky.....	Switch Engines..	Yes Sleepers&Diners	.....	.....	Truks & Sw.Eng.	Telegraph.....	1800'....	2800'..	.....
8	Union.....	Savannah, Ga.....	Switch Engines..	Yes Seldom.....	.....	None...	Trucks & Floats.	Telegraph.....	2&4m...	9300'.....	.....
9	Union.....	Columbus, Ohio ..	Yard Engines....	Yes As TrafficChange	.....	None...	Trucks.....	Telegraph.....	.....	.....	.....
10	B. & O.....	Philadelphia, Pa...	Switch Engines..	Yes Diners.....	.....	None...	Trucks.....	Station Wire.....	1m.....	.....	Not.
11	B. & O.....	Baltimore, Md....	Yard Engines....	No. 1 Sleeper to N. Y	.....	None...	Trucks.....	Thru Sta. Master..	2500'....	2500'.....	Not
12	B. & O.....	Baltimore, Md....	Switch Engines..	No. Occasionally....	.....	None...	Trucks.....	Sta. Mas. & Tower	3000'....	2500'.....	Not.
13	Union.....	Peoria, Ill.....	.....	No.	.....	None.	.....	ThruDispatch.Off	1½m....	Adj't.....	Sep. sta. empl'ees.
14	Union.....	Troy, N. Y.....	.....	Yes No.....	.....	.....	Trucks.....	Messenger.....	1m.....	1m.....	Sep. sta. empl'ees.
15	Union.....	Albany, N. Y.....	.....	Yes Yes, Connections	.....	.....	Trucks and Elev.	None.....	¾m.....	Adj't.....	.....
16	P. & R. Ry.	Reading, Pa.....	Switch Engines..	No. Yes, Connections	.....	None...	Trucks & Cars...	.....	1m.....	Adj't.....	Not.
17	Penna, R. R.	Harrisburg, Pa....	Switch Engines..	Yes Yes.....	.....	.....	Trucks and Elev.	Thru Sta. Master..	4150'....	650'.....	Not.
18	Union.....	Birmingham, Ala..	Yard Engines....	Yes Yes, Connections	.....	.....	Trucks and Elev.	Telegraph.....	¼-1m....	¼-1m.....	Not.
19	C. M. & St.P	Milwaukee, Wis....	.....	Yes Added;LocalSer.	.....	.....	Trucks and Elev.	.....	2m.....	¼m.....	.....
20	Union.....	Minneapolis, Minn..	.....	No. As Required.....	.....	.....	.....	Telegraph.....	.....	.....	.....
21	Union.....	Indianapolis, Ind...	Yard Engines....	Yes Yes.....	.....	None...	Trucks.....	Teleg. & Telephone	½ to 1¼m	½ to 1¼m*	Sep. sta. empl'ees.
22	Union.....	Toledo, Ohio.....	.....	Yes AsTrafficChang..	.....	.....	Trucks.....	ThruDispatch. Off.	Adj't....	Adj't.....	.....
23	Union.....	Nashville, Tenn...	Switch Engines..	Yes Sleepers & Diners	.....	.....	Trucks.....	Telegraph.....	800'.....	800'.....	.....
24	Union.....	Richmond, Va.....	Switch Engines..	Yes Yes.....	.....	.....	Trucks and Elev.	Messenger.....	⅞-3.7m..	½-3.7m....	.....
25	Union.....	St. Paul, Minn....	.....	No. Yes.....	.....	.....	Trucks and Elev.	Telegraph	½m.....	½m.....	Sep. sta. empl'ees.
26	Union.....	Seattle, Wash.....	.....	Yes As Required.....	.....	.....	Trucks and Elev.	.....	None...	1000'.....	.....

* Indianapolis.—Car storage yards ½ to 1½ miles distant; except Pullman yard, 600 feet.

press be received, delivered and handled below the train floor, and raised and lowered by elevators, conveniently located, to avoid interference with the movement of passengers.

The Terminal Officials' Association of Chicago appointed a committee to investigate the handling of interchange traffic and the congestion of a year ago. This committee presented a report at the meeting of that association in September (see Railway Age Gazette, October 14, 1910), extracts from which are included in this committee report. In this report the Terminal Officials' Association committee recommended that outside terminal yards supplement the local facilities, and that while several railways and belt lines are providing additional engines and yard facilities, some more radical step is needed than the improvement of these individual facilities.

The report is signed by: F. S. Stevens (P. & R.), chairman; E E. R. Tratman (Engineering News), vice-chairman; Hadley Baldwin (C. C. C. & St. L.); W. C. Barrett (B. & O.); G. H. Burgess (D. & H.); L. G. Curtis (B. & O.); A. H. Dakin, Jr., New York, N. Y.; H. T. Douglas, Jr. (W. & L. E.); A. C. Everham (C. H. & D.); M. J. Henoch (L. & N.); H. A Lane (B. & O.); L. J. McIntyre (N. P.); B. H. Mann (M. P.); A. Montzheimer (E. J. & E.); W. L. Seddon (S. A. L.); C. H Spencer (W. T. Co.); A. Swartz (Erie); E. B. Temple (Pennsylvania).

Discussion on Yards and Terminals.

E. R. Lewis (Mich. Cent.): In the definition for export pier will it be acceptable to the committee to say, "a pier" instead of "a covered pier?"

The President: The committee accepts that suggestion.

Prof. Williams (Cornell College): It would seem better to put the word "and" in the definition for coach cleaning yard, making it read "located near terminal station and track should be of sufficient length," etc.

The President: That is acceptable to the committee.

Mr. McNab: I do not see why the word "conveniently" is necessary there. We all know that a coach cleaning yard should be in a convenient location to the terminal station. Why put in the word there? Let the clause read—"The coach cleaning yard should be located near terminal station, etc."

The President: The committee accepts that amendment.

Mr. Rose: Referring to the last paragraph under "outbound freight house," it seems to me the freight could be handled more economically by building the freight house alongside the track, and switching the cars to the freight house, rather than trucking the freight down alley ways, at right angles to the freight house.

The President: The committee wishes to retain the definitions now in the manual referring to separating yards and to switching district. It is necessary to include these definitions in the committee's recommendations.

A motion to accept the committee's definitions and recommendations was carried.

Mr. Stevens: The typical track layouts that submitted with the report on passenger terminal design are intended to illustrate the text of the report, and most of the features that are shown are merely incidental. The principal object for submitting the diagrams is to really state the manner in which it is proposed to get trains in and out promptly. The location of engine houses, water cranes, etc., are incidental features which we do not consider have any particular bearing on this case. They are merely inserted to show what might be done in a terminal of that character, if conditions permitted.

The President: The Chair would like to ask the committee, if in place of ten years, it would not be wise to extend the time of the provision for economical, efficient and practically continuous operation during the periods of greatest activity, which may be reasonably expected to twenty or twenty-five years. Ten years is a short period.

Mr. Stevens: The ten year period was discussed at our meeting and was agree as a reasonable time limit to be placed on that.

George W. Kittredge, (N. Y. C. & H. R.: I think a period of ten years is too short a time for which to design a terminal station. I venture that any plant of considerable magnitude which only provided for a ten years growth would be outgrown before it is completed.

Mr. Stevens: If it is proper, I would like to invite attention to the fact that this report is based on the consideration of passenger terminals of medium size.

Mr. Kittredge: The medium station of today is the large station of tomorrow, and I think my remarks still apply.

Mr. McNab: I ask Mr. Kittredge when the Grand Central Station improvements were made a few years ago, how long they were figured for. Within my recollection, which does not go so very far back, there have been three changes made in that terminal.

Mr. Kittredge: I am sorry I cannot answer Mr. McNab as to what my predecessors figured on as to future growth when the last revision was made, but it was not ten years after they made the revision in 1899 or 1900 that they began to rebuild on the present basis. As an example of what growth has taken place since work started on the present terminal, I will say that the first contract with the city provided for the work being completed in five years from the date of beginning, or July 1st, 1908. Prior to July 1, 1908, we had to go to the city for an extension of time. We showed the city at that time that so far as excavation and construction work is concerned, we had then completed 108 per cent of all the work contemplated in 1903, when the improvement was begun, but as a matter of fact, it was only about forty per cent of what was then under contemplation.

Mr. McNab: No doubt that is an exceptional case, but I think the committee's report and its recommendation would stand in that respect.

A motion to amend the conclusion to extend the time to twenty years instead of ten years was carried.

Mr. Kittredge: In conclusion 2 why should baggage and express be "received, delivered and handled below the train floor," rather than "below or above?"

Mr. Stevens: The reason "below" is given is because general conditions will permit that construction better, and the head room can be very much less. If the handling of the baggage and express is above the train floor, probably not less than 18 ft. clear would suffice. If it is below 12 ft. is ample, probably 10 ft. would suffice.

Mr. Kittredge: In connection with the terminal at New York, where we have a double deck structure, we find it much more economical to handle baggage and mail and express that comes in on the upper level, above the tracks, and that which comes in on the lower level below the tracks. I think the words "above or below" should be substituted for the word "below."

E. B. Temple, (Penna.): I think that is a good suggestion. I am glad to know that you have made the change to twenty years instead of ten years. At the Broad Street station, Philadelphia, we find that the business increases 50 per cent every ten years. For thirty years we have been enlarging, every ten years, and are now up against the problem again.

W. H. Courtenay, (L. & N.): The discussion is being based on the largest terminals we have in the United States, and my understanding of these conclusions is that they apply to passenger terminals of medium size. Passenger terminals like that of the New York Central, and the Pennsylvania in New York City and the Pennsylvania in Broad Street, Philadelphia, are not terminals of medium size. It would seem to me that a terminal of medium size was a terminal in a city of 100,000 people or less. In cities of medium size, where the ground is of reasonable cost, it would be cheaper to handle the baggage on the same level. I do not think the committee should recommend for pessenger terminals of medium size that the baggage should be handled on a separate level, because in such cases it is very expensive, and hardly justified.

Mr. Temple: We consider that the ideal terminal should be either above the street level or below it, and it does not take any more costly facilities to have the baggage placed on a truck and run on an elevator in the case of such a station, and it is much easier to elevate the baggage to the platform in this manner. If the tracks are in the subway itself, it is as easy to move the baggage from the street level down, as to run it out to the end of the platform. We were dealing more particularly with the ideal station.

Mr. Courtenay: I would like to know what the committee considers the population of the city in which a passenger terminal of medium size would be located.

The President: The committee wishes to ask if you have any alternative conclusion to offer in place of No. 2, which expresses their opinion as to the requirements of a medium sized passenger terminal?

Mr. Courtenay: My opinion is that in passenger terminals of medium size it is better to handle the baggage on the same level. So far as I know, passenger stations of medium size are generally located on the ground surface, neither above nor below. For such a terminal the cheapest way to handle the baggage is to handle it on the same level. If there is much baggage to be handled, it would seem desirable to provide intermediate platforms.

Mr. Webb: It might simplify the matter if the constation improvements were made a few years ago, how

larger size, where large quantities of baggage and express must be handled," etc., and then follow it with another recommendation as to what the committee thinks ought to be done in these moderate sized terminals, because what is very proper and necessary for a terminal like those in New York City would not be acceptable in a city of 75,000 to 100,000 people. I think we should differentiate between the two classes of terminals and it will make the situation clearer.

C. H. Spencer, (Wash. Term. Co.): A number of states are agitating the question of the elimination of grade crossings. Some have already passed laws requiring grade crossings to be eliminated. This means that your terminals are bound to be elevated or depressed. In presenting this report the committee presented what they thought was an ideal terminal to meet what may be expected in legislation of this class. Certainly the ideal condition is the terminal that does away with the necessity of grade crossings of any kind.

G. H. Burgess, (D. & H.): In the committee's list of 26 terminals that are considered medium sized terminals, 13 are either above or below the street level. It seems to me that that largely answers the question Mr. Courtenay has raised.

C. H. Spencer: I would suggest that the committee consider the question from the standpoint of the amount of business done in the station rather than the population of the city where the station is located. You will notice in the table, that the number of trains originating and departing gives an idea of the amount of business being done in the stations. That is what should govern rather than the size of the city.

Prof. Williams: Would it not be better, since we changed the previous paragraph to twenty years, to take into account the possible growth in business of these terminal stations during the next twenty years and is it not likely that the business will increase to such an extent as to make it desirable to have this arrangement of the terminal facilities from the present time on?

Mr. Stevens: The committee considered the question of providing facilities very greatly in excess of the present requirements, but considered that would be somewhat extravagant.

Mr. McNab: As brevity with efficiency is desired by this association, I would ask the committee if they would concur in eliminating the words "desirable or" in the second line of conclusion 2.

The President: The committee accepts that.

A motion to adopt the committee's conclusions was carried.

The President: We would be glad to hear from Mr. Condron, a description of the telpher system being installed in the M. K. & T. freight house in St. Louis, Mo.

T. L. Condron, (Con. Eng.): The freight station is designed for both inbound and outbound l. c. l. freight. The building is of structural steel, 400 ft. long by 240 ft. wide, and is built so that the street on the east is about 20 ft. below the street on the west. The lower level of the station is on the level of the street to the east, or about twenty feet below the level of Broadway, and on this lower level are twelve tracks, 400 ft. long, providing for 120 freight cars of average length. Between the freight cars are twelve 12 foot platforms, and over the platforms are hatchways into the floor above. The second floor on the level of Broadway has four driveways, each 38 ft. wide, running across the entire width of the building, with a platform on each side of the driveway to which teams can back up or drive alongside. The platform space of the second floor is 3 ft. 9 in. above the street level and covers something over one acre of ground. The freight will be received from the wagons that come into the freight house on these platforms, ready to be weighed and distributed by means of overhead telphers, running on mono-rails, to the various hatchways. Likewise freight coming in will be lifted by means of these telphers to the platform level above, and distributed to the wagons. The telphers are carried on 1-beam runways suspended from the structural steel framing of the third floor, the story height between the first floor and the third floor being 34 feet; the column spacing in the building is 40 ft. in one direction and 38 ft. in the other. The telphers will pick up the freight which, in the case of small packages, will be loaded on flat boards having small castor wheels under them and suspended from a frame, so that they can be picked up by the hook of the telpher and raised through the hatchways or raised above the team floors, and passed over the area.

The President: The Chair believes that this is the first application of the telpher system to the handling of l. c. l. freight in a freight station in this country, and it will be very interesting to watch the development of this particular installation.

A. W. Thompson, (B. & O.): The telpher or Sprague system has been in operation about a year on the Baltimore & Ohio pier in Baltimore, Md. This system is similar to the one just described.

The President: Have you much l. c. l. freight to handle there or is it car load freight?

Mr. Thompson: It is both. The largest percentage is l. c. l. It is quite similar to the business done in an ordinary freight house.

The committee was dismissed with the thanks of the association.

WOODEN BRIDGES AND TRESTLES.

The work assigned was:

(1) Consider the revision of Manual.

(2) Continue to co-operate with Committee Q of the American Society for Testing Materials, and other associations, in the preparation, revision and adoption of uniform standard specifications for structural timber.

(3) Continue the study of principles and methods of pile-driving, including information on pile-drivers and equipment, analysis of practical experience in pile-driving, the strength of sheet piles, recommended types of equipment, of sheet piles, of concrete piles, and of formulas for bearing power.

H. S. Jacoby.

Chairman, Committee on Wooden Bridges and Trestles.

(4) Make concise recommendations for next year's work.

The following sub-committees were appointed:

To consider further revisions of the Specifications for Southern Yellow Pine: F. H. Bainbridge.

To consider further revisions of the Specifications for Douglas Fir and Western Hemlock: L. J. Hotchkiss.

Piles and Pile-driving: R. D. Coombs, chairman.

(a) Sheet Piles: C. C. Wentworth, chairman; L. J. Hotchkiss, I. L. Simmons, Hans Ibsen. (b) Details: W. S. Bouton, chairman; J. A. Lahmer. (c) Mechanical Pile Protection: J. A. Lahmer, chairman; F. H. Bainbridge. (d) Pile Records: F. B. Scheetz, chairman; Hans Ibsen. (e) Concrete Piles: P. H. Wilson, chairman; R. D. Coombs, J. A. Lahmer, L. J. Hotchkiss. (f) Pile-drivers: F. B. Scheetz, chairman; W. S. Bouton, G. R. Talcott. (g) Analysis of Practice: F. H. Bainbridge, chairman; F. E. Bissell, H. S. Jacoby, I. L. Simmons. (h) Bearing Power and Formula: F. E. Bissell, chairman; R. D. Coombs, F. B. Scheetz. (i) Water Jet: G. R. Talcott, chairman; L. J. Hotchkiss, F. B. Scheetz, C. C. Wentworth. (j) Overdriving: L. J. Hotchkiss, chairman; H. S. Jacoby. (k) Enlarged Foot, Screw and Disc Piles: P. H. Wilson.

REVISION OF MANUAL.

No revision of the Manual in regard to the specifications for southern pine or for Douglas fir and western hemlock is recommended, as it is considered that these specifica-

tions should be given a longer commercial use in order to develop points for possible modification.

CONCLUSIONS.

The committee recommends:

(1) That the Pile Record Form be adopted as a standard.

(2) That the Principles of Practice for Pile-driving be adopted.

(3) That the report on Piles and Pile-driving be received as information.

(4) Piling can be protected against marine wood borers by filling sand between the piles and vitrified clay pipe placed around the piles from a point a foot or two below mud line to the same distance above high tide. The expense is such that it is not advisable to apply this treatment to piling which has not been protected against decay.

The report is signed by: Henry S. Jacoby (Cornell University), chairman; F. H. Bainbridge (C. & N. W.), vice-chairman; F. E. Bissell (Civil Engineer); W. S. Bouton (B. & O.); R. D. Coombs (Consulting Engineer); L. J. Hotchkiss (C. B. & Q.); Hans Ibsen (M. C.); J. A. Lahmer (K. C. S.); F. B. Scheetz (K. C. Bridge Co.); I. L. Simmons (C. R. I. & P.); G. R. Talcott (B. & O.); C. C. Wentworth (N. & W.); P. H. Wilson (Civil Engineer).

PILE RECORD FORM.

Pile Record of Bridge ....

LOCATION ....

Weight and Kind of Hammer .... **Date** .... **19** ..

Bents Numbered from North or East End **Piles numbered from Left to Right**

Date	Bent No.	No. of Pile	Size of Pile			Kind of Wood	Cut-off	Base-rail to Ground	Total Penetrat.	Av. Last Five Blows		Kind of Soil	Remarks
			Tip End	Butt End	Length					Drop of Ham'r	Penetrat.		

APPENDIX B.

Pile-driving—Principles of Practice.

(1) A thorough exploration of the soil by borings, or preliminary test piles, is the most important prerequisite to the design and construction of pile foundations.

(2) The cost of exploration is frequently less than that otherwise required merely to revise the plans of the structures involved, without considering the unnecessary cost of the structures due to lack of information.

(3) Where adequate exploration is omitted, it may result in the entire loss of the structure, or in greatly increased cost.

(4) The proper diameter and length of pile, and the method of driving, depend upon the results of the previous exploration.

(5) Where the soil consists wholly or chiefly of sand, the conditions are most favorable to the use of the water jet.

(6) In harder soils containing gravel the use of the jet may be advantageous, provided sufficient volume and pressure be provided.

(7) In clay it may be economical to bore several holes in the soil with the aid of the jet before driving the pile, thus securing the accurate location of the pile, and its lubrication while being driven.

(8) The water jet should not be attached to the pile but handled separately.

(9) Two jets will often succeed where one fails, in special cases a third jet extending a part of the depth aids materially in keeping loose the material around the pile.

(10) Where the material is of such a porous character that the water from the jets may be dissipated and fail to come up in the immediate vicinity of the pile, the utility of the jet is uncertain, except for a part of the penetration.

(11) A steam or drop hammer should be used in connection with the water jet, and used to test the final rate of penetration.

(12) The use of the water jet is one of the most effective means of avoiding injury to piles by overdriving.

(13) There is danger from overdriving when the hammer begins to bounce, provided the head of the pile is not broomed. Overdriving is also indicated by the bending, kicking or staggering of the pile.

(14) The brooming of the head of a pile dissipates a part, and in some cases all, of the energy due to the fall of the hammer.

(15) The weight of the hammer should be proportioned to the weight of the pile, as well as to the character of the soil to be penetrated.

(16) The steam hammer is more effective than the drop hammer in securing the penetration of a pile without injury, because of the shorter interval between blows.

(17) Where shock to surrounding material is apt to prove detrimental to the structure, the steam hammer should always be used instead of the drop hammer. This is especially true in the case of sheet piling which is intended to prevent the passage of water. In some cases also the jet should not be used.

(18) In general, the resistance of piles, penetrating soft material, which depend solely upon skin friction, is materially increased after a period of rest. This period may be as short as fifteen minutes, and rarely exceeds twelve hours.

(19) In tidal waters the resistance of a pile driven at low tide is increased at high tide on account of the extra compression of the soil.

(20) Where a pile penetrates muck or soft yielding material and bears upon a hard stratum at its foot, its strength should be determined as a column or beam; omitting the resistance, if any, due to skin friction.

(21) Unless the record of previous experience at the same site is available, the approximate bearing power may be obtained by loading test piles. The results of loading test piles should be used with caution, unless their condition is fairly comparable with that of the piles in the proposed foundation.

(22) In case the piles in a foundation are expected to act as columns the results of loading test piles should not be depended upon unless they are sufficient in number to insure their action in a similar manner, and they are stayed against lateral motion.

(23) Before testing the penetration of a pile in soft material where its bearing power depends principally, or wholly, upon skin friction, the pile should be allowed to rest for 24 hours after driving.

(24) Where the resistance of piles depends mainly upon skin friction it is possible to diminish the combined strength, or bearing capacity, of a group of piles by driving additional piles within the same area.

(25) Where there is a hard stratum overlying softer material through which the piles are to pass to a firm bearing below, the upper stratum should be removed by dredging or otherwise, provided it would injure the piles to drive through the stratum. The material removed may be replaced if it is needed to provide lateral resistance.

(26) In general, timber piles may be advantageously pointed to a 3-in. or 4-in. square at the end.

(27) Piles need not be pointed when driven into comparatively soft material.

(28) Shoes should be provided for piles when the driving is very hard, especially riprap or shale, and should be so constructed as to form an integral part of the pile.

(29) The use of a cap is advantageous in distributing the impact of the hammer more uniformly over the head of the pile, as well as to hold it in position during driving.

(30) The specification relating to the penetration of a

pile should be adapted to the soil which the pile is to penetrate.

(31) It is far more important that a proper length of a pile should be put in place without injury than that its penetration should be a specified distance under a given blow, or series of blows.

Discussion on Wooden Bridges and Trestles.

The first conclusion was accepted without discussion.

Hunter McDonald, (N. C. & St. L.): I move that we add to paragraph 4 of appendix B "and the purpose for which they are intended."

Mr. Jacoby: The committee accepts that suggestion.

W. H. Courtenay, (L. & N. R. R.): I think exception might reasonably be taken to paragraph 7. In the practical operation of driving piles, unless the district is a sandy one, where facilities are ready for the use of a jet, it is quite an expensive matter to get together the apparatus for the jet. In ordinary clay, there is no difficulty in driving a pile sufficiently without jetting, to give all the adequate bearing you can expect a pile to give. A jet does not work very well in clay, and unless the clay is mixed with a very large proportion of sand, I doubt if much good would be obtained by boring holes with a jet for the purpose of placing a pile. In my own experience jets have been used for the purpose of making holes to put piles in for the sole reason that our height of base of rail above the ground was so small that we couldn't get the 70-ft. piles we intended to use in 50 ft. leads, so we had to make holes to put the piles in to get them in the leads, so the hammer could strike them. For that purpose, the cheapest expedient we could devise was to put jets in the ground to start the holes, to get them deep enough to start the pile driver. As soon as that was done, we had no further use for the jet. We have attempted to jet piles in several cases, and have always had difficulty with it. The hole is very likely to close. I do not think this committee should go on record as saying it may be economical to bore several hole in the soil with the aid of the jet, before driving the piles for the purpose of lubricating the piles going down. I do not believe those things would be necessary in order to satisfactorily drive piles in clay soil.

L. J. Hotchkiss, (C. B. & Q.): The paragraph in question refers more particularly to the driving of concrete piles. I have seen several cases myself where it was quite difficult to drive the piles without the jets, without battering up the heads of the piles, but by using the jet as mentioned in this paragraph, the piles went down without any particular difficulty. They went straight and they were got down to a penetration that could not have been reached without the use of the jet. This particular method would only apply in certain kinds of clay, clay with a certain amount of sand or loam. If it were a very stiff clay, the jet would not penetrate. I know since we have been driving concrete piles on the C. B. & Q. we have gotten into the use of the jet to an extent we never have before, and we can get piles down more economically and quickly with the jet than ever before. We have not used it very much in driving wooden piles.

W. F. Steffens (B. & A.): The committee has limited paragraph 7 to boring holes with the water jet. Another case may arise. There is a quality of soil in North Carolina through which it is almost impossible to drive piles even with metal tools. In that soil the use of an earth or clay augur would be advisable. The material so loosened can be removed, leaving a cavity into which the pile can be dropped and then seated, perhaps, with a hammer. I have in mind a case where the use of the jet was advised as a lubricating method and the augur produced a result the committee is seeking to produce entirely by the water jet.

The President: Do you recommend amending paragraph 7 by the addition of your suggestion?

Mr. Steffens: I will offer that to the committee as a suggestion.

Mr. Cartlidge: Such an important matter as that to which our attention has been called should be considered by the committee, and some additional statement brought in later to apply particularly to such a case. I would prefer that the committee bring in a supplementary statement next year.

The President: Is that satisfactory, Mr. Steffens?

Mr. Steffens: I think that would be more desirable.

Mr. Courtenay: I think paragraph 8 is a little too sweeping. On the L. & N. we are now driving piles 100 ft. long through 55 ft. of water. The bottom is sand. We get the piles down very satisfactorily with the aid of a jet to a depth of about 10 ft., and then we strike a stratum of hard material, and we have great difficulty in getting it through. The current is exceedingly strong there—it is tidal current, first north and then south, depending on whether the tide is running in or out. In the case which I cite, I think it would be impossible to jet the piles without the jet being attached to the piles. The current is so swift in the water that a deep-sea diver can't hold himself to the pile without being practically chained to it. In many places, where there is occasion to jet piles down, the jet pipe must necessarily be attached to the pile. Otherwise the two would become to widely separated the jet would do no good.

H. B. Dick (B. & O. S. W.): It used to be the practice on the construction of government jetties to attach the galvanized iron pipe, one to either side of the pile, and a flexible rubber hose was connected from the top of the pipe to the pump. That seemed to be the only successful way in which they could put down piles in sand.

Mr. Hotchkiss: My personal experience with the jet and the pile has been that the jet caught so fast you could not get it down. I remember in one case where the jet was broken.

Mr. Courtenay: We use wrought iron pipe attached to the pile with staples. It would be impossible in 50 ft. of water, with a swift current, to sink a pile with a jet except by attaching the jet and the jet pipe to the pile.

Mr. Hotchkiss: If we could say in this paragraph under consideration that the water jet should not be rigidly attached to the pile, I think that might meet the condition.

Mr. Courtenay: As this matter is general, I think it best to omit No. 8.

Mr. Steffens: What would happen in the case of a concrete pile, cast with the jet hole in the middle? Would the jet be attached on the outside?

Mr. Jacoby: I think there is more difficulty in the jet clogging when it it is a part of the pile than in any other case, and certainly the trend of present practice is to handle the jet separately.

Mr. Courtenay: I move No. 8 be modified to read: "water jet should not be attached to the pile, and should be handled separately when piles are driven in dry ground, but not when they are driven through water."

Mr. Jacoby: Would not Mr. Courtenay's idea be satisfied if we should say "in general the water jets should not be attached to the pile, but handled separately."

Mr. Courtenay: I have no objection to that, but I think

Mr. Jacoby: The Committee will insert the words "in general."

Mr. Courtenay: I would suggest the elimination of the words "provided the head of the pile is not broomed," in paragraph 13. Piles may be damaged by over-driving when heads are broomed as well as otherwise.

Mr. Jacoby: The idea is that if the head is allowed to be broomed the effect of the hammer then becomes lost in large part and the bouncing of the hammer will not indicate any injury in any other part of the pile. It is true, in many cases, that the brooming of the head of the pile indicates also that the driving should be stopped, but the rapidity with which the brooming develops and other indications should show to the one in charge what the conditions really are.

Mr. Courtenay: I think those words are misleading. I have seen piles absolutely broken when their heads were broomed, and as a general proposition I would say that when the heads are badly broomed, you may expect more damage has been done to the piles than when the heads are not broomed. On driving piles on several occasions, I have had to take them out. I have found them badly broken in a variety of ways, and the heads were broomed.

E. H. Fitzhugh, (G. T. Ry.): It is almost the universal custom in driving piles now to use a cap, and when the cap is used, there is no bromming.

Mr. Courtenay: We drive many thousand piles a year and we don't cap them, we ring or band them.

A motion to eliminate the words: "provided the head of the pile is not broomed," in paragraph 13, was carried.

Mr. Loweth: Referring to paragraph 15, I do not see how we can readjust the weight of the hammer every time we have a different length of pile. I suggest that we modify that to read, "the weight or the drop of the hammer."

The President: That is satisfactory to the committee.

Mr. Jacoby: The committee desires to change the numerals in paragraph 26 from 3 in. or 4 in. to 4 in. or 6 in., because a square of 3 in. is too small.

Mr. Courtenay: I would like to see paragraph 26 eliminated. If a pile could be driven without an iron shoe, I

would not advocate pointing them at all. Personally, I am pretty suspicious of piles that are driven with an iron shoe. I think a large proportion of them are damaged.

A. J. Himes, (N. Y. C. & St. L.): I have driven piles through the material in the beds of streams in Pennsylvania that were full of large pieces of flat rock and boulders without the use of shoes, without any difficulty.

J. B. Jenkins, (B. & O. R. R.): I have often found pointing very advantageous. I have made it a practice to drive them without pointing when I could, however. Frequently it has been difficult to get them in at all without pointing

E. B. Temple, (Penn.): In hard material piles should be pointed or they may split at the lower end and may not drive safe.

H. D. Porter, (B. & L. E.): If you eliminate paragraph 26, I am afraid it will give the impression that this convention does not believe in pointing piles. Where you are driving piles into soil that is broken up you can get them to go the way you want them to go better by pointing them, as they will not be deflected by small stones or hardened material. Where we drive piles in an old road bed we point them, as a rule, and in a great many cases use steel points.

A. F. Robinson, (A. T. & S. F.): There are many places where there are boulders and cinders and it is almost impossible to drive a pile unless it is pointed. In other cases where the soil is such that the piles have to be sharpened. If we cut out the paragraph about pointing our piles, then we will have to modify the paragraph covering the shoe which almost necessarily means the pile must be sharpened.

R. G. Kenly, (M. & St. L.): There are certain times when piles should be pointed, and I move as an amendment to Mr. Courtenay's motion that the two words "in general" be omitted from that paragraph and let the latter part of the rule stand as it is.

Mr. Porter: If we say that piles may be advantageously pointed to a 4-in. or 6-in. square at the end, you indicate that that can be done under any and all circumstances, and I do not think any one is trying to advocate that. There must be some modifying expression in place of "in general" without saying "timber piles may be advantageously pointed."

J. P. Snow (B. & M.): Let Mr. Kenly change his amendment so we can put in "in some cases," and allow the word "advantageously" to remain.

Mr. Kenly: That is satisfactory, but I do not see the necessity for it.

The amendment to make the paragraph read "timber piles may be advantageously pointed in some cases to a 3-inch or 4-inch square at the end" was adopted.

William McNab: I ask the committee what they mean by using the word "comparatively" in that clause? Their idea of comparatively may be different from ours. If it has any meaning it is all right. If it has no meaning, I move to strike it out.

Prof. Jacoby: This is quite a large country and the soil conditions certainly vary very considerably, and the interpretation of a word like "comparatively" must have considerable latitude in itself.

Mr. McNab: The word "comparatively" is all right for the present moment, but when it appears in our Manual and comes before us in print we do not know what the committee's meaning of comparatively was, and you can get the same meaning in this clause if you leave out the word.

The President: The committee is willing to accept your suggestion, Mr. McNab.

Mr. McNab: Is clause 29 necessary? Is it necessary to tell the association that the us of a cap is advantageous?

Prof. Jacoby: I think it may fairly be said without any reflection upon the engineering profession that the advantage of the use of a cap is not adequately appreciated throughout the entire country. I might refer to one instance in which a large number of the very finest longleaf yellow pine piles were to be driven in a certain location. Rings were employed and the results were not satisfactory and then the cap was used. At first, in order to see whether the cap would be of special value, a thin plate was placed on the pole and it was found the piles could be gotten into position without apparent injury, which, without the plate, could not be done. The cap was sent for and used with entire satisfaction.

Mr. McNab: I move that clause 29 be eliminated as superfluous to the report.

Mr. Stevens: It may be pertinent to remark that I have seen piles driven by the use of caps of thin boards of soft wood, where it was aboslutely impossible to force them down by the use of rings. The piles would split in spite of the rings, and with the use of caps of soft wood the piles would drive without any apparent injury. As a general proposition the piles will drive better with a cap of soft wood across the top of the pile than rings.

Mr. Kittredge: I would amend Mr. McNab's motion and retain the paragraph in this form: "The use of a cap is sometimes advantageous."

L. J. Hotchkiss, (C. B. & Q.): In this question we are considering not only the driving of timber piles with which we are all familiar but the driving of concrete piles as well, with which many of us perhaps are not familiar. There is no way of driving a concrete pile without a cap unless you want to smash it to pieces.

The amendment was put to a vote and was not agreed to.

Hunter McDonald, (N. C. & St. L.): I move that the word "need" in paragraph 27 be stricken out and the word "should" be substituted in its place. The reason is in No. 20 we are told a pile driven in soft material must be treated as a column and nothing is said about how much power you figure on for the column.

The President: The committee accepts your suggestion changing the word "need" to "should."

Mr. Himes: We use pile foundations and permit the concrete to rest directly on the piles and to cover a situation of that sore I would suggest that we say "Where masonry is to bear directly on the piles such portions of the piles as may have been injured by contact with the hammer should be removed."

The President: That matter will be considered by the committee and reported on next year.

The principles of practice for pile driving included in conclusion 2 were adopted.

G. D. Brooke (B. & O.): I would like to go back to the "pile record form." To bring this form into conformity with the form of the Committee on Records and Accounts, it should be headed with the letters A. B. and C. R. R. and with the size of the sheet stated.

The President: The committee accepts that suggestion.

Section 3 of the conclusions was received as information without discussion.

H. A. Lloyd (Erie): Instead of adopting conclusion 4, I move that we accept it as information. It may or may not be true. I think it is just as valuable for the public at large and this association if it is adopted for information.

The motion was carried.

The committee was dismissed with the thanks of the association.

IRON AND STEEL STRUCTURES.

The subjects assigned were:

(1) Revision of Manual.
(2) Report findings on effect of impact on bridges.
(3) Recommend specifications for bridge erection.
(4) Report on secondary stresses.
(5) Report on influence of theory, experiment and experience on bridge design.
(6) Rules for instruction and guidance of inspectors in mill, shop and field.
(7) Make concise recommendations for next year's work.
(8) Make definition of the word "culvert" as distinguished from "bridge."

In addition, the chairman was advised by the board of direction to hold a joint meeting with the Roadway Committee for the purpose of reconciling the specifications for clearances in bridges and tunnels. This meeting was held on December 30, 1910, in Chicago. The committee reported to the board that it would recommend the insertion, in paragraph 2 of the specifications for Iron and Steel Structures as printed in the edition of 1910, after the word diagram in the second line, the following, "the height of rail shall, in all cases, be assumed as 6 in."

In the case of subject (1) the committee has no changes to recommend, except to correct minor typographical errors. In appendix "A" will be found a report by the chairman of the sub-committee on Impact. In appendix "B" are submitted specifications for bridge erection. In Appendix "C" is a report from the sub-committee on Impact, concerning secondary stresses.

The time at the disposal of the committee has not been sufficient to make a proper report on the other subjects put before it, and it is requested that they be referred back to the committee for further consideration.

With regard to next year's work, your committee would

suggest the employment of a reporter on subjects connected with design and maintenance of steel structures, whose duty it will be to collate reports of prime interest and report them to the committee, as information, which, after being considered and passed upon, may be laid before the Association to be printed in bulletins, so as to be accessible to the membership. The committee recommends that a study of the design of large columns be taken up, and suggests that collaboration with an existing joint committee, appointed for the same purpose, would, perhaps, bring about valuable results.

CONCLUSION.

The committee recommends the adoption of the specifications for bridge erection for publication in the Manual.

The report is signed by: C. H. Cartlidge (C. B. & Q.), chairman; A. J. Himes (N. Y. C. & St. L.), vice-chairman; J. A. Bohland (Gt. Nor.); Charles Chandler (C. G. W.); C. L. Crandall, professor railway engineering, Cornell University; J. E. Greiner, consulting engineer, Baltimore; B. W. Guppy (B. & M.); Charles M. Mills, consulting engineer, New York; C. N. Monsarrat (C. P.); C. D. Purdon (St. L. S. W.); A. F. Robinson (A. T. & S. F.); C. C. Schneider, consulting engineer, Philadelphia; I. F. Stern (C. & N. W.); F. E. Turneaure, dean of College of Engineering, University of Wisconsin; J. R. Worcester, consulting engineer, Boston.

C. H. Cartlidge.

Chairman, Committee on Iron and Steel Structures.

APPENDIX A.

Impact Tests.

Organization.—The importance of the subject of Impact and the lack of adequate information relating to it has been the cause of frequent discussion in the Association, and especially in its committee on Iron and Steel Structures. Funds provided by the railways for a series of tests on structures in service, with the special object of studying the effect of moving loads on such structures. Experiments were conducted in the field during the seasons of 1907 and 1908, and the data from these field tests have been worked up in this report.

Instruments.—The instrument used was designed especially for these tests by the chairman of the sub-committee, and was described at the annual meeting of the Association in 1907.

Test Trains.—The test train used in each case was made up of a selected type of locomotive followed generally by a sufficient number of loaded cars to cover the span. By the arrangement adopted speeds of 60 miles per hour or over were generally obtained, even with freight locomotives.

General Method of Conducting the Tests.—In the case of truss bridges it was the aim of the committee to secure data relative to the deflection at or near the center of the span, and the deformations in all the various kinds of members. With the 12 extensometers in use it was possible to cover the various kinds of members reasonably well with a comparatively few changes of instruments. Generally the tests on the upper and lower chords were confined to one panel, but in most cases at least two of the eye-bars composing a chord member were tested. The same thing is true of diagonal members composed of eye-bars. In carrying out the tests the train was headed in the more favorable direction for speed, and was moved back and forth over the structure at various rates of speed. Such speeds were selected as to cover fairly the range from about 20 miles per hour to the maximum attainable. A few movements were made at from 10 to 15 miles per hour. Little difference was noted in the results at various speeds below 15 miles per hour, and, in general, the results at 10 miles per hour may be considered as practically equal to static stresses. The speed of the train was determined by the use of stop-watches and signals made by observers stationed at the ends of a 500-foot base line. (In the case of very high speeds a 1,000-ft. base line was used.) The locomotive was generally working steam when crossing the span, but in some cases it was not. Differences in this respect caused no noticeable differences in results, so far as the field observers were able to judge, although this point was considered mainly with respect to the higher speeds.

Results.

Causes of Impact in General.—The following may be enumerated as the chief factors in causing impact: (1) unbalanced locomotive drivers; (2) rough and uneven track; (3) flat or irregular wheels; (4) eccentric wheels; (5) rapidity of application of load; (6) deflection of beams and stringers, giving rise to variations in the action of the vertical load.

The term "impact" is here used to include any effect of the moving load which results in stresses exceeding the static stresses. Where caused by open joints or rough or flat wheels, this impact is more or less of the nature of a "blow" on the structure; but where caused by the other factors mentioned, it amounts in effect to a varying load or a series of impulses acting upon the structure. In either case the result is to produce deflections and stresses in excess of the static values, such excess of stress being commonly called "impact" stress, or simply "impact."

The experiments obtained in these tests as well as the results obtained in former tests indicate that with track and rolling stock in good condition the main cause of impact is the unbalanced condition of the drivers of the ordinary locomotive. The result aimed at by the mechanical departments is to so counterweigh the wheels as to secure a reasonable compromise between the effect of the rotating parts and the reciprocating parts. This requires the use of counterweights considerably in excess of the amount necessary to balance the rotating parts. So far as the vertical effect on the track is concerned the reciprocating parts are of little influence, but by whatever amount the rotating parts are overbalanced, just so far will there be a variation in pressure on the rail, due to the centrifugal force of such overbalance.

In consequence of the action of these centrifugal forces during the passage of a train, the load acting upon the bridge is a varying one. It varies with each rotation of the driver, and thus acts as a series of impulses tending to set the structure into vibration. In the case of short span bridges these impulses will be repeated only two or three times during the passage of the locomotive, but in the case of long span bridges they will be repeated many times. If now these impulses correspond in period with the normal rate of vibration of the loaded structure, the effect will be cumulative and the vibrations will be greatly increased. Such cumulative effect cannot occur for bridges of very short span length, as the normal rate of vibration of such structures is higher than the rate of rotation of the drivers at the highest practicable speeds. It may and frequently does occur in structures of span lengths as low as 75 ft. and sometimes less. The speed at which the impulses here discussed show a cumulative effect may be termed the critical speed. This is discussed more fully in following paragraphs.

Other causes of impact are less readily studied than that of locomotive counterbalance. The condition of track and wheels can be defined in rough, general terms only. The effects of these elements, as shown by the tests, were also in most cases such as to make it difficult to express them quantitatively. In same cases the behavior of the loaded cars was such as to cause large impact.

Time of Vibration of Bridges.—A theoretical deduction of a convenient formula which expresses the time of vibration of a loaded bridge in terms of weight of structure and

its load, and the static deflection due to the live load will give

$$T = \sqrt{\frac{w+p}{p}} \times d,$$

in which T = time of vibration of loaded structure in seconds.

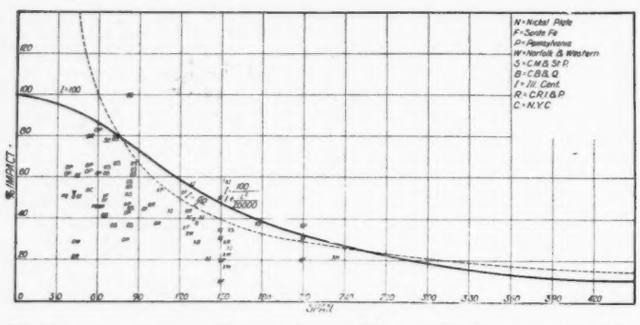
w = dead load per foot, assumed as uniform;

p = live load per foot, assumed as uniform;

d = static deflection in feet due to load p, as determined by direct measurement.

Critical Speeds.—The speed of the train which will produce cumulative vibration, as described above, depends on the natural rate of vibration of the loaded structure and the diameter of the locomotive drivers. During the passage of a train the total weight on the structure varies to a considerable extent and hence the normal rate of vibration of the structure also varies. Exact agreement, therefore, between driver rotation and vibration period of the structure will exist only for a short time, and hence the cumulative effect will not continue during the passage of the locomotive entirely across a long span structure. The results show clearly the importance and significance of critical speed on all bridges exceeding about 100 ft. in span length. In all such spans it was found that the excess of deflection or stress at high speeds, over the static effects, was due almost wholly to cumulative vibrations, produced at or near this critical speed.

Law of Impact at Critical Speed.—A theoretical analysis of the ideal case of the effect of a rotating weight on the deflection of a beam when such rotation is in phase



Maximum Impact Percentages, Plate Girders and Main Members.

with the vibration period of the beam itself and there producing cumulative effect shows the amplitude of deflection due to the centrifugal force of such rotating weight is given by the expression $x = 2\pi n \frac{Gr}{2W}$, in which G = weight of arm, r = arm of rotating body, W = weight of beam, assumed as concentrated at the center, and n = number of revolutions of weight from beginning of motion. The effect of friction or other resistance in absorbing the energy is not taken into account in this theoretical analysis.

The case of a bridge supporting a rolling load consisting of unbalanced wheels is somewhat similar to the theoretical case here analyzed. The masses are distributed instead of being concentrated and the absorption of energy prevents the development of vibration to the extent assumed by the theory, but the relations brought out in the analysis may be useful in interpreting results. Where the rotating wheels synchronize with the natural period of vibration of the loaded structure then the vibrations will be cumulative somewhat as assumed in this analysis.

We would then conclude that the amplitude of vibration in such a case would be proportional to the moment of the counterbalance and inversely proportional to the weight of the loaded structure. Such vibrations would also increase in amplitude with the number (n) of impulses due to the rotating weight. Obviously the amplitude will not increase indefinitely as the impulses are repeated, but will soon reach a maximum limit where the energy absorbed balances the energy applied by the rotating body.

Maximum Impact Percentages for Truss Spans.—While the individual results vary somewhat, it is thought that an average value for the main truss members will be more significant than the maximum obtained from any one. The extensometer measurements are affected more or less by secondary stresses, and the instruments themselves are not quite as reliable as the deflectometer, so that, on the whole, an average value for these main truss members was considered to be a fair measure of maximum impact for all similar members. It will be seen that the impact values determined from these main members are somewhat greater than the values determined from the deflection records. This is to be expected, partly on account of the effect of secondary stresses, and partly on account of the fact that the deflection itself represents in a measure an average of all of the truss members, and should be somewhat less than the average of a few members.

Effect of Position of Counterbalance.—It is not to be expected that the exact position of counterbalance would have any appreciable effect on spans of any considerable length; but on short-span girders, whose length does not exceed two or three times the circumference of a driver, it would seem that there would be an appreciable difference in impact whether the counterbalance happened to be down or up at the time when the drivers were centrally located on the span.

A marked tendency to give the maximum impact when the counterbalance was in its lowest position was noted, although the variations due to other causes are so great as to mask this effect to a large extent.

Effect of Speed in Application of Load.—Assuming the track perfectly smooth and all of the rotating parts perfectly balanced, the effect of a load moving over a structure at a high rate of speed depends wholly upon the vertical curvature of the track and the effect which this curvature has upon the path over which the center of gravity of the load travels. If the load causes the structure to deflect so that the curvature of the track is concave upward, the pressure of the load upon the bridge will be in excess of its weight by reason of the centrifugal force caused by such curvature. If the track has an initial camber so that when the load passes over the structure the deflection produced is just sufficient to bring the track into a straight line, then there would be no centrifugal force developed and the pressure of load upon the track will be constant and exactly equal to the static load. The impact in that case will be zero.

If we assume the track originally straight and absolutely rigid, the amount of impact or centrifugal force resulting from the deflection of the structure can be approximately determined on theoretical grounds. Such an analysis has been made by Dr. H. Zimmerman for the case of a single rolling load, and a formula which is very closely approximate to his exact formula is as follows:

$$F = P \frac{1}{gl^2/16\,v^2 d - 3}$$

in which F = centrifugal force, P = weight of rolling load, v = velocity in feet per second, d = deflection of structure and l = span length.

Considering the fact that for spans or any considerable length the track is cambered, and the abutments not rigid, we may conclude on theoretical grounds that the impact due to speed of application for spans greater than 50 ft. is of no consequence.

The experimental data with reference to this point are very difficult to obtain by reason of other elements which are always present. The results obtained from balanced compound locomotives and electric locomotives are, however, very significant and indicate that under very favorable conditions as to track and rolling loads the impact is of very little consequence even for short spans.

Effect of Rough Track.—The effect of low or open joints in the track was directly noticeable on stringers and short span girders, and sometimes on floor beams and hip verticals where the rail joints were near the floor beam. It was not noticeable on main truss members or long span girders. The effect produced was, however, very difficult to determine quantitatively. Under these conditions the extensometers were so jarred and shaken up as to make the diagrams unreliable.

Effect of Design.—The most noticeable effect of differences in design is to be seen in the results obtained on stringers and floor beams. The extreme condition of rigidity is illustrated in the results obtained in bridge No. 5 where the rail was supported on steel channels riveted directly on closely spaced crossbeams, and these in turn into the lower chord of the truss. No observations were here made on the crossbeams, but the records obtained on hip verticals indicate a very severe jarring effect transmitted from the rail into the floor system. Many similar results were obtained with the ordinary open floor where the stringer spacing was such as to bring the rail nearly over the stringer. In this case the ties would afford but

little elasticity and the jarring effect resulting from rough track or wheels was very noticeable in nearly all such cases. Where the stringers were widely spaced the elasticity due to long ties relieved this jarring effect very greatly and in most cases gave records nearly or quite free from instrumental vibration.

The effect of a ballasted floor on the results obtained on floor beams was even more marked than that of widely spaced stringers. The most noticeable effect of elasticity of bridge floor was freedom from jar, as shown by lessened instrumental vibration. The actual effect on impact percentage is very difficult to estimate because of the unreliable character of the records taken on the more rigid floors.

The effect of length of panel was not detected, although the deflection of the stringers undoubtedly has some influence on the cumulative vibration when the panel lengths correspond approximately with the driver circumference or the car length.

The effect of design on main girders and truss members

Table of Centrifugal force at 60 M.P.H. in % of static load on Drivers

R.R.	Engine No.	Weight of Engine only	Diam. of Drivers	Stroke	Weight on Driver Axle	Weight of over balance at Crank pin center		Centrifugal force in % of Static Load on Drivers at 60 M.P.H.
						Total	Per Wheel	
	1013	188000	79"	28"	51000	797	399	29
	904	203500	63"	30"	45250	919	230	31
	1018	188000	79"	28"	51000	797	399	29
	47	157200	63"	28"	40750			
	20	157200	63"	28"	40750			
	34	157200	63"	28"	40750			
	234	149700	69"	26"	38930	567	189	22
	1919	210000	69"	28"	52300	756	252	23
	1921	210000	69"	28"	52300			
	2527	187000	84¼"	26"	46500	694	347	22
	2523	187000	84¼"	26"	46500	694	347	22
	2123	216000	69"	28"	48600			
	2703	196600	78"	26"	51000	Balanced	Compound	
	2543	187000	84¼"	26"	46500	694	347	22
	1703	178900	62"	28"	44300	1352	451	60
	304	166800	68"	26"	41330	782	261	29
	925	177500	84¼"	28"	46225	1632	816	57
	263	177000	69"	30"	45300	786	262	30
	939	177470	84¼"	28"	46225	1632	816	57
	1672	206000	63"	30"	48800	908	227	29
	819	193000	69"	26"	46000	762	254	25
	1746	198600	63"	30"	44300	856	214	30
	2200	238850	63"	32"	56150	964	241	28
	147	160000	62"	28"	35500	692	173	29
	185	159000	72"	26"	39000	366	122	13
	181	123700	68"	24"	40300	486	243	26
	573	164000	63"	28"	44010	1233	411	54
	1403	201500	79"	26"	49600	Balanced	Compound	
	1822	248200	69"	28"	57700	Balanced	Compound	
	1824	248200	69"	28"	57700	Balanced	Compound	
	1115	210190	69"	28"	50180	1205	402	38
	542	201500	73"	26"	49600	Balanced	Compound	
	1435	204100	79"	26"	56850	Balanced	Compound	
	1066	210190	69"	28"	50180	1205	402	38
	1059	200000	56"	30"	42960	596	149	27
	1033	200000	56"	30"	42960	596	149	27
	594	196250	68"	28"	45645	267	89	10
	603	167700	79"	28"	41970	403	202	18
	494	200000	56"	30"	42960	596	149	27
	7204	193500	55"	28	46000	632	158	26
	7027	176600	77"	26"	55300	537	270	17
	7451	207775	80"	26"	61625	Balanced	Compound	
	3883	191000	78"	26"	54400	650	325	21

is difficult to determine. In considering this problem it should be kept in mind that the main factor in causing impact or excess of stress in main girders and truss members is the cumulative vibration set up by the unbalanced locomotive drivers. This effect cannot be eliminated by the most perfect design for the reason that the structure is an elastic body and subject to deflection and vibration from such causes as here considered.

It is to be noted that anything which decreases the rate of vibration of a structure tends to reduce the impact by reducing the critical speed which causes maximum impact. This rate of vibration is reduced by an increase of span length, by an increase of mass and by an increase of deflection under a given load. In the case of short span structures not affected by cumulative vibration the same general influences prevail, excepting that the rate of vibration does not directly enter, since the critical speed is not reached.

Impact Under Cars and Effect of Flat Wheels.—During the progress of the special tests the sub-committee on Impact made such observations as it could relative to the effect of flat spots on car wheels on the stresses in bridges. In one series of tests a car with a wheel having a very decided flat spot was purposely used, and in other tests wheels with flat spots were occasionally noted in the test trains. In one case the tires of the locomotive were badly worn and quite rough. From these observations it is impossible to report any quantitative results. A distinct effect was noticeable on such members as stringers and floor beams. This effect was similar to that produced in the case of rough track. The effect of flat spots on main truss members of a bridge was not definitely noticed in any case.

Maximum Probable Impact as Indicated by These Tests.—In attempting to derive an expression which will represent maximum impact, it is necessary to distinguish between short-span structures, for which the maximum speed is less than the critical speed, and long-span structures, for which the critical speed is likely to occur. It seems reasonable to consider as a basis of conclusions the impact percentages plotted in plate IX. This diagram represents impact percentage for plate girders and trusses based on deflections, and also those based on flange stresses and stresses in main members of trusses.

For short spans a percentage of 100 would appear to be high enough. For long spans, such that the maximum impact is dependent upon the critical speed, theoretical considerations indicate that the impact varies inversely with the span length. Following this suggestion from theory, a curve has been plotted on plate IX, represented by the formula $I = 60/l$, where I = impact percentage and l = span length. This curve is shown by the dotted line. It seems to accord fairly well with the results of the tests, but it may be considered that there are perhaps too many values above this line.

It is very desirable that the law of maximum impact be expressed by a single formula. Adopting as approximately correct the two expressions above mentioned for short and long spans, namely, $I = 100$ for short spans and $I = \frac{60}{l}$ for long spans, a single formula may be derived which will represent fairly well the entire range of span lengths. Such a formula is represented on the two diagrams by the full line. Its equation is

$$I = \frac{100}{1 + \frac{l^2}{20000}}$$

On the whole, this single curve fits the observations quite as well, or better than the two lines representing the different groups of span lengths. This curve is not presented here as a general impact formula, but simply as a curve which represents satisfactorily, in the judgment of the sub-committee, the maximum impact percentages obtained in this series of tests.

Summary of Results.

The following summary of results relates only to the series of tests which have been made by the sub-committee:

(1) With track in good condition the chief cause of impact was found to be the unbalanced drivers of the locomotive. Such inequalities of track as existed on the structures tested were of little influence on impact on girder flanges and main truss members of spans exceeding 60 to 75 feet in length.

(2) When the rate of rotation of the locomotive drivers corresponds to the rate of vibration of the loaded structure, cumulative vibration is caused, which is the principal factor in producing impact in long spans. The speed of the train which produces this cumulative vibration is called the "critical speed." A speed in excess of the critical speed, as well as a speed below the critical speed, will cause vibrations of less amplitude than those caused at or near the critical speed.

(3) The longer the span length the slower is the critical speed and therefore the maximum impact on long spans will occur at slower speeds than on short spans.

(4) For short spans, such that the critical speed is not reached by the moving train, the impact percentage tends to be constant so far as the effect of the counterbalance is concerned, but the effect of rough track and wheels becomes of greater importance for such spans.

(5) The impact as determined by extensometer measurements on flanges and chord members of trusses is somewhat greater than the percentages determined from

measurements of deflection, but both values follow the same general law.

(6) The maximum impact on web members (excepting hip verticals) occurs under the same conditions which cause maximum impact on chord members, and the percentages of impact for the two classes of members are practically the same.

(7) The impact on stringers is about the same as on plate girder spans of the same length and the impact on floor beams and hip verticals is about the same as on plate girders of a span length equal to two panels.

(8) The maximum impact percentage as determined by these tests is closely given by the formula

Discussion on Iron and Steel Structures.

Mr. Cartlidge: There are three changes desired by the committee. In the first paragraph of section 3 of Appendix B we desire to interpolate a sentence after the word "erection" in the second line, reading: "False work will be built by blank." In the last line in that paragraph the words "railroad company" to be replaced by a blank space. In the last paragraph in this section, interpolate in the second line between "used" and "by": "as far as practicable," so that this sentence will read "false work placed by the railroad company under an old structure or for carrying traffic temporarily over a new opening may be used as far as practicable by the contractor during erection; provided it is not unnecessarily cut and wasted." Each one of these blank spaces is to have a dagger referring to the footnote at the bottom of the page, as follows: "Insert railroad company or contractor, as the case may be"

(The secretary then read paragraph 4.)

Mr. Loweth: I don't like the wording of the second paragraph of section 4. The contractor has to get certain authority from the engineer, according to the first line, and certain other authority from the railway company, according to the last line. I think the contractor should be obliged to take from the same person all the information and direction necessary in the conduct of this work, and I would suggest that that clause be changed to read "tracks shall not be cut nor shall trains be subject to any other delay except a reduction of speed, other than authorized by the engineer."

The President: The committee accepts that amendment.

Mr. Earle: In the first clause of section 4 it says, "and so as not to interfere with the work of other contractors." In doing work of that kind, if there are two or three contractors, it is absolutely necessary that one will interfere with the other, and as the work is done under the supervision and in accordance with the directions of the engineer, it seems to me it would be better to leave those words out.

The President: The committee is not willing to accept that.

Mr. Steffens: In the last clause of No. 4 is the usual flagman provision. On some railroads there is a question of the responsibility of the flagman involved, and the specifications for contracts all read that the flagman shall be at the service of the contractor, in order to place responsibility.

Mr. Loweth: I should think that section 5 is in conflict with section 4. They may not be in conflict always, but there are methods of erecting steel bridges whereby these clauses would be in conflict. It is provided in the first clause that there shall be no work train service furnished free, except for unloading material. I know that frequently material is unloaded direct from the cars and put into the structure direct, and some times it is taken from the nearest yard and unloaded, and put into its place in the work. I think the two paragraphs in the heading 5, may be in conflict in a number of methods the contractor might adopt for erecting steel bridges.

Mr. Snow: I have found it necessary in cases like Mr. Loweth has instanced, to make an estimate of what would be a fair charge for unloading. If the material is put right in place, of course the contractor must expect he is going to have free service, while he is erecting his bridge, and in that case, you can simply make an estimate of how long it will take the train crew to unload the material, in the ordinary way. I think the clause is pretty good as it stands. The word "only" helps the matter out.

Mr. Porter: In clause 5 I would like to suggest omitting the words "free of charge." Then in the next sentence I would suggest omitting the word "free." This service, under the Interstate Commerce Act, I understand, cannot be furnished unless it is a part of the contract by which the structure is furnished so that it is not necessary here to know whether it is free or whether it is to be paid for, but is simply a guide in showing what kind of service should be furnished to the contractor, which may either be paid for by the contractor or may be furnished free, in accordance with the contract, so that it would read: "When work train or engine service is furnished the contractor, such service shall consist only in unloading materials, and in transferring the same from a convenient siding," etc.

Mr. Steffens: I would like to see the second sentence in clause 7 stricken out so that it will simply read: "The railroad company's engineers will establish lines and elevations."

The President: The committee makes the point that it is not advisable to eliminate this, because they want the contractor to check the measurements and be a check on the work.

C. E. Smith: It has been my experience that unless you have that clause in the contract and a penalty attached to it, the contractor will go ahead with the work until he finds a discrepancy, and he will notify the engineer, and unless you put a clause in there to make him responsible for his work, he will not be so careful.

Mr. Robinson: This paragraph is intended to prevent long delays or the getting out of a lot of material on to a a bridge for assembling, only to find out, after they get a couple of hundred tons of metal that something is incorrect. The engineer who has established the levels and the lines, is usually not on the ground when the superstructure is erected, and what was intended in this specification was advice to the contractor that before he commences running out iron on to his false work, he should make his necessary rough checks to see whether the distance from base of rail to masonry would allow his iron to go in or whether he could get his iron in between the parapet walls or one the piers.

C. E. Smith: I would like to state a case that happened on the main line of the Iron Mountain about three years ago. They were putting in a small bridge, I think a 36-ft. span. They got the span ready to put it in. The contract provided that the contractor was to check the masonry work before he put it in. He slid his span out, and tried to get it in, but could not because the steel was a little bigger than the opening. The main line was tied up about twelve hours, and I don't doubt but that there are other members who could give similar experiences. There was no redress against the contractor, because the specifications simly said he should "check."

A motion to refer paragraph 7 back to the committee was carried.

The President: In the second paragraph of section 9, beginning with the second sentence, the committee proposes to eliminate the sentence "any changes desired to be made by th railroad company for insuring greater safety to traffic shall be made by its own forces." We also omit the word "and" and begin the sentence "no claim on the part of the contractor for delay or damage on account of such changes will be allowed."

C. E. Smith (Mo. Pac.): Paragraph 8 appeares to assume that all the material will be delivered by a contractor. While this is possible in the case of one or two bridges of considerable tonnage, it is not likely in the case of a large number of bridges of small tonnage, that the contractor will run up excessive demurrage charges and have his men running around from point to point. I move that there be inserted at the beginning of the third line preceding the word "materials" the following: "Where steel work is to be unloaded by the contractor the material shall be placed on skids above the ground," etc.

Mr. Steffens: This sentence as it now stands makes a contractor liable for demurrage charges, and it might be, as Mr. Smith cites that the railway company is under obligations to unload. There might be a case in which the railway does not unload its own material.

Mr. Steffens: The first sentence of paragraph 10 implies the structure is going to be used again, that is, it shall be dismanteled without unnecessary damage, the second sentence begins "when the structure is to be used elsewhere." It would be well to have the first sentence begin "unless otherwise ordered" because there are a large number of old bridges coming out to-day that are scrapped immediately.

The President: The committee changes the words "steel work" in the first line of section 11 to "material."

Mr. McNab: Will the committee consent to remove the words "or abuse" at the end of the first sentence?

The President: The committee accepts that.

Mr. Steffens: I should like to ascertain the views of

the members as to whether it is good practice to depend entirely on the bolts without pins to carry the traffic. There is nothing relative to additional rivets required beyond the usual number, plus the excess. Also, if the contractor loses a number of rivets, should not the rivets that he needs to finish the structure be furnished at his own expense? It seems to me that should be incorporated as a final clause.

Mr. Cartlidge: Mr. Steffens' suggestion as to the limit of rivets is well taken and the committee will incorporate it in a reconsideration of the specifications.

Mr. Courtenay: Referring to section 12, it frequently happens that there are a number of misfits in bridges, and it does not seem to me to be necessary to specify that the engineer shall be there or his accredited representative, always, to actually watch the rectification of the minor misfits. They are reported at the engineer's office, and he can take such steps in connection with the matter as he considers necessary. The question for debate is whether the man shall stand there and see the mechanical work done.

Mr. Cartlidge: That is the idea of the committee. The presence of the engineer during the correction of minor misfits is not necessary, but there are many cases when the engineer is necessary when misfits of a major character are being remedied, and the committee has felt that is a point which should be watched by the engineer and it is good practice to recommend that it be done.

Mr. Steffens: Is it necessary to specify that the hole shall be drilled after the metal is placed? There are certain examples I personally know of where it was a decided advantage to drill them in advance, where it was not contemplated to imbed the bolts in the masonry at that time. The holes were drilled in advance of the steel work.

Mr. Cartlidge: There is no rule without its exceptions. It is very likely that some occasions might arise in which it is preferable to drill holes in the masonry before the steel work with shoes is set, but it is undoubtedly a fact that there are a thousand cases where the contrary is the fact, and we cannot in a specification as general as this cover all the little variations which may occur in carrying them out.

C. F. Loweth (C. M. & St. P.): I hope in reconsidering this the committee will find a way in which they will permit the use of sheet lead in bed plates in paragraph 14.

Mr. Steffens: I hope the committee will see fit to cut that clause out. This matter is one that depends upon the accuracy of the engineering.

Mr. Cartlidge: The committee considered the use of sheet lead and decided against it. This question is entirely apart from the levels of the masonry, or the position of the castings. It is something which provides an accurate bearing for bed plates upon a more or less roughened surface. It is impossible to make the bed plate and bridge seat so smooth as to be an ideal bearing surface and the use of a joint between the casting and a bridge seat in good practice.

The President: The committee recommends the elimination of the words "The railroad company" in paragraph 15, putting the figure with the footnote as on the first page, and the insertion of the words "frame and" between the words "place" and "the."

The committee desires to change the word "contractor" in the first line of paragraph 16 to a blank.

The committee desires to change the second line of paragraph 18 by inserting between the words "employee," and "skilled"; the word "only."

Mr. McNab: Clause 20 says he shall assume all responsibility for injury to the workmen or the public. I think it would be better language to say "to the workmen and to the public."

The President: The committee accepts that.

Mr. Snow: Could not the last paragraph of clause 20, where it says: "he shall comply with the local and government laws," be omitted? I cannot see the necessity of saying that a man shall conform to the laws of the land.

Mr. Cartlidge: It is necessary to call attention to the fact that in the place he may be going, there may be local ordinances to which he must accommodate himself and be governed. This is a clause that would tend to keep him out of trouble.

Thomas Earle (Penna. Steel Co.): Is it the intention of the committee that the contractor shall be responsible for any injury to passengers of the railway company when, through negligence of the railway company they go through a bridge of false work which the contractor has in place.

Mr. Cartlidge: Nothing that the committee may do or say in these specifications will affect the responsibility for an accident caused by negligence. The law is clear as to where the responsibility shall be placed. The railway company is necessarily responsible to the public under the law.

Mr. Earle: We have had advice that the contratcor can, if he wishes to, insure the railway company, and the execution of this specification if made a part of the contract might in certain courts be so construed that the contractor would insure the railway company.

Mr. Cartlidge: That is the intention, to make an insurance clause out of this. Clause 21 says the contractor shall carry such liability insurance as is neecssary to protect himself against loss or damage caused by injuries to his men, etc.

C. E. Smith: We have been informed by our legal department that it is satisfactory for some contractors on erection to do their work without liability insurance. We have recently finished up a contract for erection with a contractor in which the contractor did not carry liability insurance. We took the matter up with the legal department, and they in turn took it up with the bonding company, and the bonding company stated it was their loss if there was any. They investigate the financial standing of the erection company. If they are not satisfied that the erection company is financially sound to carry their own liability they do not issue a bond. I suggest that the committee consider that statement.

Walter Loring Webb: I want to call attention to the fact that there is a matter in clause 9 which will not stand in the courts. It is perfectly conceivable, and perhaps has happened that a railway company has made changes which they might excuse on the ground of greater safety, which would actually make increased cost to the contractor. In a case of that kind, the court would unquestionably allow the contractor damages, and there is no use in putting in a clause saying that the contractor must do that, if the court would not sustain the specification at all.

Mr. McNab: In regard to clause 22 what is the difference between the "accredited representative of the chief engineer" and the "properly accredited representative of the chief engineer."

The President: The committee is willing to have the word "properly" eliminated.

A motion that the specifications be referred back to the committee was carried.

Prof. Jacoby: I desire to offer the following which has a bearing on the matter of secondary stresses:

In connection with steel bridges there is hardly any material available in published form relating to the lessons taught by the observation of bridges under traffic conditions. All over the country bridge inspectors are making their rounds, looking at the details of bridges and making records of conditions discovered and recommendations as to repairs required. After the repairs are made the incident is closed for that structure, and so the matter goes on year after year. There must inevitably be some important lessons taught by the extensive experience of these inspectors which should influence design much more largely than it apparently does. One reason is that the maintenance department is entirely separate from the bridge department in which the designs of new structures are developed. There are doubtless also other influences at work. Designers and draftsmen have but little opportunity to become familiar with these matters by direct observation. It seems that each railway does not get the full benefit of the experience of the maintenance department, thus leading to the continued construction of some faulty details because the designers do not learn, except incidentally, of the actual behavior of bridges previously designed by them.

For example, certain designs of brackets on end floor beams perform their duty in an excellent manner under heavy modern live loads, and the conditions of adjacent track, while others show marked defects; yet the defective designs are built over and over again on the roads in which the maintenance of way department has discovered their weakness.

This condition is not confined to steel bridges. I am convinced that some railways are losing at least two or three years of service in their Howe trusses because of the lesser relative efficiency of the splices in the lower chords. This is an indication that there are details in timber framing which are not receiving sufficient study by designers, although similar timber structures have been used for many years. This is probably true because the conditions under which failure occurs are not brought to the attention of designers.

The committee was discharged with the thanks of the association.

MR. WICKHORST'S TALK ON RAIL MANUFACTURE.

Last evening at eight o'clock, M. H. Wickhorst, engineer of tests of the rail committe, gave a talk on the manufacture of steel rails and a short description of some of the results of the extensive tests he has conducted for this committee during the past year.

In opening Mr. Wickhorst described the reduction of the ore in the blast furnace, then the three processes for making rail steel, the open hearth, the Bessemer and the electric. The latter process is just now coming into use, and possesses the advantage of not requiring a fire at the furnace, as the power may be secured from some distant point. Mr. Wickhorst then went into a discussion of the structure of steel, especially its chemical composition, explaining the relations of the pure iron or ferite, and the carbon element, or pearlite. He compared the rail steel to concrete, with the varying portions of ferite and pearlite intermingled. Slides were shown indicating the position from which sections were removed from rail for analysis and tests, and the reasons for selecting the various locations explained.

He showed a number of sections of rail with split heads and pipes and also slides of sections of rail which showed quite plainly inclusion of tie-plates in the rolling. He dwelt some length on the results of investigations made by the rail committee which are included in the report of the committee, and will be discussed more in detail today.

The talk was heard by a crowd that filled the Florentine room.

THE SMOKER.

The first "smoker" in the history of the American Railway Engineering and Maintenance of Way Association was given in the Florentine room of the Congress hotel last night. In past years the association has stuck exclusively to the very serious business for which its conventions are held, except on the evening of its annual dinner. This year the Committee on Arrangements decided the members needed a little more diversion; and they had it.

The smoker followed M. H. Wickhorst's illustrated lecture on steel rails, and was attended by a crowd that filled the room and overflowed into the lobby. The entertainment was started with a generous distribution of sandwiches, cigars, beer in large, white steins, and Apollinaris water for those who taboo anything stronger than mineral water. Frank Coates, of the committee on arrangements, announced that Caruso was singing in New York City at that moment, and that the committee had made arrangements to transmit the music directly to the Florentine room. The medium of transmittal proved to be a "leetle German bant" of six pieces—mostly punk—which strenuously discoursed the strident airs with which it is accustomed to coaxing coins from the pockets of passersby on the streets. They say the committee tried to hire the band for the evening at a fixed stipend, but that it refused to come if denied the opportunity of passing the hat as usual; so it was allowed to pass it. With the band for accompanist and professional entertainers for choristers the crowd sang all the familiar smoker airs, including "We're Here Because We're Here," "The Good Old Summer Time," "How Dry I Am"—for which there was no provocation—"When Good Fellows Get Together" and "What the 'Ell Do We Care?"

In the midst of the singing a tramp vaudevillian blew in at one of the doors of the room asking for "My friend, Lou Fritch." When he found his friend, and began combing out his tangled back hair with his hand, Mr. Fritch caused a laugh by begging him "not to comb them off in here; they might crawl."

The evening's entertainment was concluded by the introduction of three typical street piano playing Italians—two men and one woman—with their hurdy-gurdy. They played the airs which begin to become familiar to every townsman at about moving time.

The novel entertainment features were intended mainly to furnish amusement for the entertained while they were mixing socially, and they served their purpose well. Never in the history of the association did so many of its members get together merely to spend a few hours in getting better acquainted as men can only on such an occasion. The committee on arrangements of the maintenance of way association is composed of W. A. Wallace, chairman; W. A. Christian, F. R. Coates, A. S. Baldwin, J. B. Cox, E. H. Lee and O. J. West.

SIGNAL ASSOCIATION MOVING PICTURES.

The Edison moving pictures taken at the last annual meeting of the Railway Signal Association at Richmond, Va., were shown under the auspices of the Chicago Signal Club at the rooms of the Western Society of Engineers, Monadnock Building, Chicago, Tuesday evening, March 21. A large number of signal engineers were in attendance, and many who were at the convention had the pleasure of seeing themselves in action in the parade, and at the baseball game. The pictures were supplemented by some excellent new Edison films never before shown in public.

WESTERN RAILWAY CLUB.

The Electrification of Chicago Railways was the subject of a paper read by C. A. Seley, of the Rock Island, at the regular meeting of the Western Railway Club last evening. The paper dealt largely with the report of the Boston Commission, and discussed in detail its various conclusions, by comparing the conditions in Boston and Chicago and showing the similarity of location and requirements. Mr. Seley said that at Boston the conclusion was reached that "Electrification, while desirable, is not necessary, nor is it required on grounds of public safety. It is desirable mainly on account of added convenience and comfort, and the author believes the same applies to Chicago." The paper was discussed briefly by W. K. Barnum, Dr. W. F. M. Goss, W. E. Symons, A. E. Manchester and J. F. DeVoy.

A contract has been given to J. D. McArthur, to build a branch line of the Canadian Pacific from Estevan, Sask., to a point 55 miles west of that place. Contracts are said to have been given recently by this company for building lines in Western Canada as follows: Two lines out of Swift Current, Sask., 80 miles; from Moose Jaw, 35 miles, and from Lacombe, Alb., 60 miles, to Foley, Welch & Stewart, St. Paul, Minn.; three branch lines out of Wilkie, Sask., 82 miles, to W. A. Dutton, Calgary, Alb., and for double-track work from Moose Jaw west for 23 miles and east for 10 miles, to J. G. Hargrave & Co., Winnipeg, Man. An officer writes that contracts have been let to Janse, McDowell & Co., Calgary, Alb., for building 42 miles of the Kootenay Central south of Golden, B. C.

MECHANICAL PROTECTION OF PILES AGAINST MARINE WOOD BORERS.*

On the Louisville & Nashville the methods most extensively used to protect piles against marine wood borers are:

(1) Encasing the piles in a rich mixture of Portland cement and sand, or Portland cement, sand and fine gravel filled between the piles, and removable flasks of wood, or wood and iron.

(2) Filling sand between the piles and vitrified clay pipe

*From Appendix E of a report presented by the Committee on Wooden Bridges and Trestles at the annual meeting of the American Railway Engineering and Maintenance of Way Association.

slipped over the tops of the piles (after heads of piles have been freed) and left in that position, pitch being mixed with the sand at the top.

The cost of the first method is reported to have been in the neighborhood of $1.50, and of the second about $1.10 per linear foot of pile protected. Better results were obtained from the use of Portland cement concrete than from a mixture of cement and sand.

The mortar or concrete filled between the flask and the pile mixed with the mud at the bottom to such an extent that the lower part of the protection often broke off. It was found impossible to overcome this entirely. A more serious fault was the cracking and breaking off of the upper part of the encasement. The second method was adopted to avoid these weaknesses. It is reported that this method gives fairly good results, and has been in general use on the Louisville & Nashville Railroad since 1893. When a section below the top fails it is removed and the upper sections are lowered, after which a new section is formed at the top by fastening cast iron casings (which come in two halves) around the pile and filling as before.

On the Louisville & Nashville the protection was applied to creosoted piles, which Mr. Courtenay, chief engineer, states had been standing in sea water for a sufficient length of time to be no longer immune from the teredo.

In 1902, the Port Arthur Canal & Dock Company, a subsidiary of the Kansas City Southern, protected a large number of untreated pine piles at Port Arthur, Tex., by placing a 24-in. sewer pipe around the piles and filling a mixture composed of one part Portland cement and one part sand between the piles and the sewer pipe. Part of the decks of the wharves were renewed at the sam time. In case the pile to be treated came under a portion of the deck that was renewed, the sewer pipe was dropped over the head of the pile. In case the cap was not displaced, the sewer pipe was cut into halves longitudinally, and after being placed around the pile was fastened together by means of wire. The protection extended from a foot or two below mud line to a little above high tide.

OVERLOADING OF PILES.*

In an endeavor to tabulate the general indications of overdriving, in order that it may be avoided as much as possible, the following suggestions are given for discussion:

(1) In the majority of instances, overdriving is indicated by the behavior of the pile.

(2) The use of a drop hammer instead of a steam hammer and the absence of a water jet often lead to overdriving.

(3) Splices, unless made with great care, are a possible cause of overdriving.

(4) A gradual decrease in the penetration per blow, followed by a sudden and large increase, is often caused by overdriving.

(5) Brooming, shattering or buckling of the pile may all be indicative of overdriving.

(6) The bouncing of the hammer is often an indication that further hammering will result in overdriving.

(7) The dull sound of the blow during overdriving is said to be of sufficient difference to be readily distinguishable.

THE WATER JET.

The first authentic use of the water jet was in 1852, during the construction of a wharf at Decrous Point, Texas. The jet was in general use during the Civil War and tradition gives the early forties as the date of its discovery. It is said that a government engineer standing in the soft mud around a pile-driving operation could not extricate his feet, and that on turning a hose on them he sank deeper and kept sinking as long as he applied the water. After he was extricated he tried his discovery on the piles, reasoning that if he sank into the mud when a jet of water was applied at his feet, the piles should either sink likewise or offer less resistance to driving.

In the late fifties or early sixties a civil engineer named Stevens applied this method in driving screw piles. In order to facilitate the work of screwing the piles into place he attached a pipe to the side of the pile, passing the nozzle through a hole cut in the disc, thus bringing the water to the point of the pile, the idea being merely to loosen the material and facilitate the screwing down of the pile. On the application of the water it was found that the pile sank readily into place by the action of the jet alone without the use of the screw point.

The water jet is essentially a stream of water forced through a pipe or hose alongside the pile. The flow of water loosens the material, and either washes it out, leaving a depression into which the pile sinks, or by lubricating the surface of the pile reduces the side friction. The use of two jets is generally advantageous in securing a more accurate direction or control of the pile.

Water simply poured on the ground around a pile while driving, not applied as a jet, will in some soils materially facilitate the driving, in one instance on record reducing the number of blows of the hammer nearly 50 per cent. Piles driven this way showed a bearing power equal to those driven on the same work without the use of water.

The jet may be used alone or in conjunction with some other method of driving, or, when the material is suitable, a hole may be jetted, the jet removed and the pile dropped into it and brought to bear by hammering.

When the jet has been used in rather dry, light soils it has been shown by tests that the action of the water tends to puddle the material around the pile and that as soon as the water has been absorbed by the surrounding earth or has been drained away, the jetted piles show a greater skin friction than piles driven in the same material without the use of the jet.

There is a difference of opinion upon the part of engineers as to the relative merits of keeping one or all of the jets near the foot of the pile, or of having at least one jet between the surface of the ground and the foot.

In either method the jets should be kept moving in order to facilitate the flow of the water around the pile and to prevent the so-called "freezing" or sticking fast.

In some cases two jets have been used placed on opposite sides of the pile, in order to obtain sufficient volume of water and to keep the pile in alinement. In other cases a single jet, slightly in advance of the pile, has given satisfactory results.

In sand, where the jet acts for some distance, a number of piles may be sunk together. It is claimed that in sand the volume of water is the principal consideration, but that in gravel, etc., a considerable pressure is also required and that holes can be jetted near the foot of the pile into which a boulder will roll out of the way of the pile. On the other hand, it is also stated that in coarse gravel the jet washes out the sand and allows the boulders to roll to the foot of the pile and impede its progress.

There appears to have been very little development in the water jet since its first introduction, and but two U. S. patents; the improvements which have been made are in the method of handling. One of the patented devices uses the water pressure to handle the jet pipe, which acts as a movement of the plunger or jet pipe is controlled by valves at the lower end plunger inside of a pipe suspended from a derrick or pile-driver; the vertical of the suspended pipe.

It does not seem desirable to use a jet pipe smaller than about 2 in. in diameter, on account of the loss of head, due to friction, in the smaller sizes, but this should be reduced at the nozzle in order to increase the velocity, as it is the velocity which loosens the material; the quantity, however, is necessary to bring the material to the surface.

Satisfactory results have been obtained with pressures ranging from that furnished by a single hand pump up to a pressure of 200 lbs. per sq. in. at the pump. The quantity of water supplied at the nozzle runs as high as 500 gallons per minute, 250 gallons per minute giving satisfactory results in compact sand.

STEAM HAMMERS.

Steam hammers are of two general types—single-acting and double-acting.

In the former and older type the steam pressure is applied to the under side of the piston and raises the hammer, which falls by gravity. The force of the blow depends upon the length of the stroke and the movable weight, and the number of blows depends upon the pressure.

In the double-acting type the steam pressure both raises

*From Appendix C to the report of the Committee on Wooden Bridges and Trestles, presented at the annual meeting of the American Railway Engineering and Maintenance of Way Association.

and lowers the hammer; the force of the blow, as well as the rapidity, being a function of the pressure.

The later apparatus is more compact, lighter and operated with much greater rapidity.

DESIRABLE FEATURES OF A TRACK PILE-DRIVER.

(1) Steam hammer. To secure greater rapidity in driving and with less injury to the pile than secured by the drop hammer.

(2) Water jet apparatus.

(3) Turntable allowing practically a complete rotation. In most cases the work can be done from either side, and in many of the remaining cases it is possible to foresee the nature of the work and to head the driver in the proper direction at the nearest "Y" or turntable. Sometimes, however, the turning facilities may be far distant, or a pile-driver may be caught between two washouts when it becomes essential to be able to turn the machine to perform the work at both places.

(4) Swinging leads. The leads require an efficient rigging to permit driving piles with a batter in either direction. When driving across the track on such work as driving bents for an adjacent track, it is convenient to be able to drive with the leads not fully raised, so as to secure the proper batter.

(5) Self-propelling mechanism. The greater the tractive force and speed the more independent is the pile-driver from locomotive service. They should preferably be sufficient to dispense with a locomotive except for long hauls.

(6) Restricted projection on the side opposite the leads when swung across the track and without unnecessary weight.

(7) High-speed power device for raising the leads. On a main line it is frequently possible to drive only one or two piles before running to a siding. In some cases the character of this apparatus to raise the leads determines whether a single pile can be driven between trains or delaying a train.

(8) Adequate overhang. To enable machines to drive piles as far ahead of the leading wheels and as far sidewise as possible. On work for double-tracking the sidewise reach should be sufficient to drive a bent on the new track from a position on the old track.

(9) Facilities for driving below the track.

(10) Ability to shift the hammer when the leads are down.

(11) No obstructions in the view of the engineman and niggerhead operator.

(12) Length of leads. To accommodate the longest piles practicable.

(13) Strength and rigidity of supports for leads and hammer. They should be adequate to handle the hammer and the heaviest wooden pile without damage. It is now becoming important to be able to handle concrete piles.

(14) Stability. The driver, while standing on its own wheels, without any jacks or special supports, should be able to pick up and drive a pile in any position within its reach.

(15) Flush ends. For convenience of transportation in freight trains, no part projecting beyond the drawheads. Otherwise an idler is required, which then may be used as a tool car.

(16) No lengths of steam hose that might be replaced by pipe.

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Talcott, G. R., Asst. Engr., B. & O. R. R., Chicago, Ill.
Taylor, E. B., Jr., Div. Engr., Penna. Lines, Logansport, Ind.
Taylor, W. D., Chief Eng., C. & A. Ry., Chicago, Ill.
Tebbetts, G. E., Br. Eng., Kansas City Term. Ry., Kansas City, Mo.
Temple, E. B., Asst. Ch. Eng., Pennsylvania R. R., Philadelphia, Pa.
Thomas, Chas. E., Gen. Foreman Water Works, Ill. Cent. R. R., Chicago, Ill.
Thompson, A. W. (Director), General Manager, B. & O. R. R., Baltimore, Md.
Tomlinson, A. T., Dist. Eng., Grand Trunk Pacific Ry., Cochrane, Ont.
Thompson, F. L., Engr. B. & B., I. C. R. R., Chicago, Ill.
Thrower, D. W., Roadmaster, Y. & M. V. R. R., Memphis, Tenn,
Tuthill, Job, Asst. Eng., C. H. & D. Ry., Cincinnati, O.
Von Schrenk, Herman, Dr., Supr. Timber Pres., R. I.-F. Rys., St. Louis, Mo.
Walker, W. K., Div. Eng., Mo. Pac. Ry., Wichita, Kan.
Wallace, W. A., Chicago, Ill.
Warren, G. T., Div. Eng., B. & O. R. R., Parkersburg, W. Va.
Webb, Walter Loring, Con. Eng., Philadelphia, Pa.
Wentworth, C. C., Prin. Asst. Eng., N. & W. Ry., Roanoke, Va.
West, O. J., Cons. Eng., Chicago, Ill.
Weston, C. V., President South Side Elev. R. R., Chicago.
Weston, George, Board Sup. Eng., Chicago Traction, Chicago.
White, R. C., Div. Eng., Mo. Pac. Ry., Little Rock, Ark.
Wickhorst, M. H., Eng. of Tests, Rail Committee, Aurora, Ill.
Wiggins, W. D., Div. Engr., Penna. Lines, Pittsburg, Pa.
Williams, S. N., Prof. C. E., Cornell College, Mt. Vernon, Ia.
Wirth, A. A., Div. Engr., Penna. Lines, Pittsburg, Pa.
Wishart, J. A., Ch. Draftsman, C., R. I. & P. Ry., Chicago.
Wood, B. A., Chief Eng., M. & O. R. R., Mobile, Ala.
Woods, A. A., Res. E., A. & V. and V. S. & P. Rys., Vicksburg.
Yager, Louis, Div. Eng., Northern Pacific Ry., St. Paul, Minn.
Young, J. C., Signal Engr., Union Pacific R. R., Omaha, Neb.
Zinck, K. J. C., Civil Eng., Winnipeg, Can.
Zook, M. A., Eng. Const., C. G. W. R. R., Chicago.

ASSOCIATE MEMBERS.

Buehler, Walter, Minneapolis, Minn.
Dufour, F. O., Asst. Prof. Str. Engr., Univ. of Ill., Urbana, Ill.
Earle, Thos., Supt. B. & C. Dept., Penna. Steel Co., Steelton, Pa.
Foote, F. S., Jr., Inst. Ry. Eng., Univ. Ill., Urbana, Ill.
Fulks, E. B., American Creosoting Co., Chicago. Ill.
Harton, W. H., Eng. M. W., S. C. & C. St. Ry., Newport, Ky.
Howson, E. T., Civil Eng. Editor, Railway Age-Gazette, Chicago, Ill.
Kammerer, A. L., Consulting Timber Engineer, St. Louis, Mo.
Mordecai, Augustus, Consulting Engineer, Cleveland, Ohio.
Ritter, Louis E., Consulting Engineer, Chicago.
Shipley, G. B., Prest., Pitts. Wood Pres. Co., Pittsburg, Pa.
Sperry, H. M., Res. Man., Gen. Ry. Signal Co., Rochester, N. Y.
Stewart, A. H., Eng. M. W., N. Q S. S. Ry., Cleveland, O.
Tate, N. S., Res. Eng., Grand Trunk Pac. Ry., Watrous, Can.
Wilson, P. H., Civil Engineer, Philadelphia, Pa.

At the Coliseum

On account of space limitations the exhibits in the balcony at the Coliseum are smaller than some of those on the ground floor, but their size is no criterion of their interest. It was thought that there would be much less attention paid to the balcony exhibits than to those more prominently situated, and it was hoped that the Monorail Car would serve to call the attention of visitors to those exhibits which could not be accommodated on the ground floor. But the car and the exhibits are both interesting enough in themselves and are attracting large numbers to the balcony.

An indication of the great interest that is being shown in methods of highway crossing protection is found in the large number of devices for this purpose which are to be seen this week at the Coliseum. There are crossings with bells of many shapes and sizes, and warning signs in every style that is calculated to attract and hold the attention of drivers and automobiles. The bells and signs are mounted on iron posts and some are even shown surmounting reinforced concrete poles. The bells are adaptable to every conceivable condition of track circuit and track arrangement, and, on the whole, represent a quality of apparatus and a general neatness in design that permits of their use in city streets and where crossing protection of the kind they afford is considered necessary.

On account of the great interest which electric railway managers are now manifesting in signaling apparatus, the exhibition of various forms of signals which are designed especially for alternating-current operation is attracting a great deal of attention. Some of the signals which are constructed for indications of this kind are to be seen in a number of exhibits. There are signals adapted to give both day and night indications by means of colored lights which are so carefully designed and arranged with respect to efficiency that their indications can be distinctly seen from a 1,000 to 2,000 ft. in daylight, and almost as far in bright sunlight. In addition to the light signals there are many forms of semaphores giving indications in both the upper and lower right-hand quadrant, and the lower left-hand quadrant. There is also quite a showing of standard steam railway semaphores and their operative mechanisms, and one company shows a disc signal of the same type that has been used for many years on railways which is designed to protect the users of highway crossings. The red indication is controlled by the presence of a train within a mile or so of the crossing, and is supplemented by a warning sign printed in large letters on the face of the box enclosing the disc and mechanism.

USES OF VANADIUM STEEL.

Vanadium cast steel locomotive frames are being called for in locomotive specifications by railways that have used them for the last three years. Considering the readiness with which these castings are made, and the satisfactory service they give, the Vanadium Sales Company of America, Pittsburgh, Pa., expects that for many purposes the more expensive forgings will be replaced by this steel.

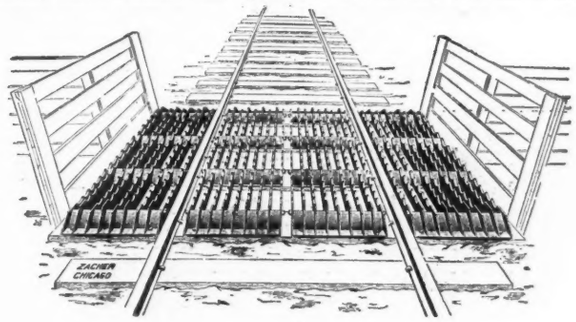
METAL STOCK GUARDS.

The subject of surface stock guards for railway crossings has been an open one for several years, and is still being discussed by railway engineers. Many designs in both wood and metal have been tested.

These years of experimental work have demonstrated that a satisfactory stock guard must embody the principles of moderate first cost, low maintenance cost, strength, and durability. It must be of strong construction, and at the same time have enough vibration after being installed to frighten animals that attempt to cross, also be rigid enough to cause pain should the vibrating qualities be insufficient, but not rigid enough to injure permanently either employes or stock.

Owing to the difficulties of building a surface guard of wood that will meet those requirements, some railways are again turning toward steel. The initial cost of steel guards has been an important item in the past, but, owing to the increase in the cost of suitable lumber for guard construction, the difference in cost has greatly decreased and the greater first cost is offset by the lower cost of maintenance. A metal guard of proper construction requires little attention after being installed, but gives effective service during its natural life, or until accidentally destroyed.

Some have raised the question as to the life of a steel



Metal Surface Guard.

guard on account of the corrosion caused by exposure to salt water drippings from refrigerator cars. Such objection has been recognized by metal guard makers, but it is being eliminated by the growing tendency to equip refrigerator cars with drip tanks.

The accompanying illustration shows one of the seven designs of stock guards made by the National Surface Guard Company, Chicago. This company has spent a number of years in experimenting and developing these different types and has tried to cover the field entirely, furnishing a suitable guard for territories where conditions require special construction, and at a reasonable price.

WHARTON UNBROKEN MAIN-LINE SWITCH.

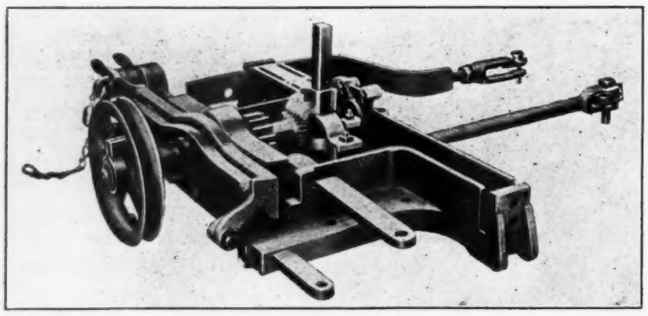
The unbroken main-line switch, made by Wm. Wharton Jr. & Co., Inc., Philadelphia, Pa., was first brought out more than fifty years ago, and it is a curious fact that this switch, in an improved form, is still used to a considerable extent on a number of roads throughout the country.

The Wharton exhibit, in spaces 9, 10, 27, 28 and 29, includes one of these switches, made in accordance with the Chicago & Alton standard.

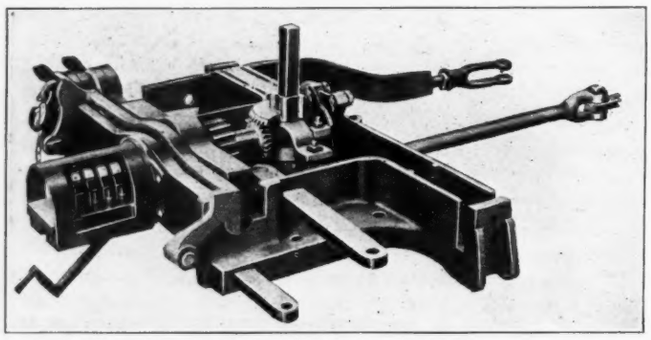
TRIPLELOCK SWITCH STAND.

The importance of safely operating and locking railway switches at junction points and cross-overs has long been realized. Apparatus has been devised to care effectively for the proposition where switches are grouped, but single switches in the main track, where the trains run at a high rate of speed, have not received any great amount of attention. The interlocking plant for groups of switches is an expensive installation for a single switch. The Triplelock switch stand has all the features of an interlocking plant. While it is very simple in construction, it is strong and reliable, rigidly locking the switch-points mechanically both in the stand and with duplex bolt locks. It has the derailer movement and derailer lock under the control and

operation of the switch and signal levers. It also controls the mechanical or electrical signal and can be operated either from a distant point or by the approach of trains through the action of the track circuit. All stands have an



Triple-Lock Switch Stand, Equipped for Controlling Mechanical Signal.

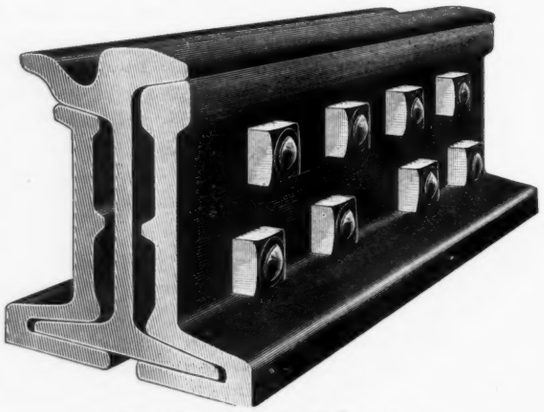


Triple-Lock Switch Stand, with Circuit Breaker for Use in Automatic Territory.

automatic manual control lock, making it impossible to insert padlock unless the lever arms are in a normal position. This device is made by the W. F. Bossert Manufacturing Company, Utica, N. Y.

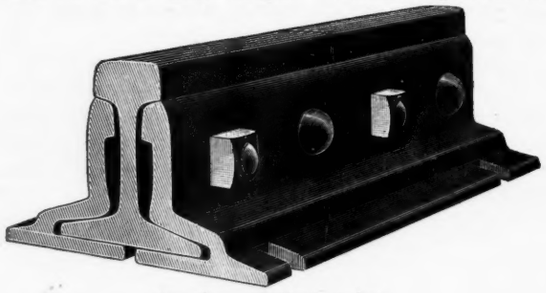
RAIL JOINTS.

Over fifty thousand miles of track are now equipped with the base-supported joints illustrated herewith, which are made by The Rail Joint Company, New York. They are rolled from the best quality of steel billets and are made to any desired length and to fit any section. Contraction

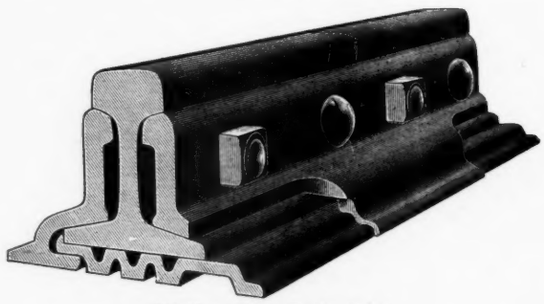


Continuous Girder Rail Joint.

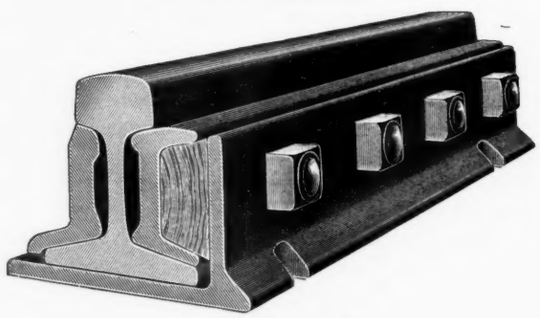
and expansion of the rails are well taken care of, and the joints are also designed to give adequate support to the rail base, maintain rail alinement, eliminate low joints, communicate the load wave uninterruptedly from rail to rail, control all vertical action between the rail ends, and prevent crystallization and the breaking of copper bonds or terminals. These features give smooth riding and reduce the cost of maintenance of both track and rolling stock. The cost of the joint is but little more than that of angle bars and its life is much longer. The same general design



Continuous Rail Joint.



Wolhaupter Rail Joint.



Weber Rail Joint.

of base support is used in the manufacture of compromise or step joints and insulating rail joints, the latter being made in the Weber and Continuous type only. These joints received the highest award at the Paris exposition in 1900 and at Buffalo in 1901, and the gold medal award at St. Louis in 1904.

REINFORCED CONCRETE FENCE POSTS ON THE PENNSYLVANIA LINES.

The Pennsylvania Lines are now making cement posts at nearly a dozen points, and in many instances the posts have been shipped from those plants to neighboring divisions for experimental purposes. One of the plants is on the P. F. W. & C. at Warsaw, Ind., and is representative of those operated by this company. Large numbers of posts have been made at this plant, and most of these have been set along their right of way near Warsaw, though several carloads have been sent to neighboring divisions for setting. The location of this plant seems ideal for making concrete posts for many reasons, the principal one being that it is located in an old gravel pit, where an abundance of the finest materials for their manufacture is at hand. The conditions for curing the posts are also ideal, for the gravel has been taken out till the ground level is only about one foot above water level, so the surface of the ground is always moist. High banks on three sides break the wind, which is detri-

mental to the curing of concrete of any kind, and the ground, being soft, is easily leveled, so that posts have bearing full length while curing.

Equipment manufactured by the D. & A. Post Mold Company, Three Rivers, Mich., is used by the Pennsylvania Lines This equipment consists of what are termed gang molds, and a frame called a shaker, which supports the individual molds up from the ground about two feet. The individual molds are U-shaped in cross-section, making a post with a round back and flat face. There are no corners or crevices to fill in molding, no projections or holes through the post, and no corrugations to weaken the post so it will break in handling. No staples or fence fastening device of any kind are inserted in the post while molding, though they can be easily placed if desired. The fence is fastened by short pieces of wire called tie wires, which go round the posts and wrap the line wires of the fencing, which are intended to be placed on the flat side of the post. It is possible to fasten the fence at any place on the post, at a cost of not to exceed about one cent per post.

The open face of these molds allows the use of any kind or style of reinforcement, such as plain or two-ply cable wire, corrugated or twisted steel or iron bars of any kind, or any of the trussed reinforcements. While these special trussed or roughened reinforcements are necessary in dry-tamped concrete in order to supply mechanical bond of the concrete to the steel, it is considered unnecessary where wet concrete is used. It is true that these special forms, or manufactured trusses, make good posts, but the cost for reinforcement alone is as much, and often more, than the cost of a post equally strong, of same size and shape, properly reinforced with the hoop reinforcement. Reinforcement to be most efficient should be near the surface, and should be distributed in units of small cross-section.

The U-shaped cross-section makes a nearly square post, with the objectionable exposed corners of a square post eliminated. It is believed by some that the triangular post possesses merits by reason of the saving of materials over the square, but if the fence is placed along one flat side it will be found that the half of the post next the fence contains three times the materials the opposite half or corner does, and with equal reinforcement in each corner the concrete will crush on the back corner under about one-half the load necessary to crush the flat side. The square post has a larger cross-section, allowing the use of a coarser aggregate, thereby saving cement.

The shaking for settling the concrete gives the post a very smooth, dense surface, which makes it almost impregnable to the action of the elements, thus preserving the reinforcement to a maximum degree. Further facts are given in "Concrete Posts and How to Make Them," a fully illustrated booklet published by the D. & A. Post Mold Company.

SINGLE TRACK HIGH-SPEED INTERURBAN SIGNALING ON A LARGE SCALE.

The Illinois Traction System, through Vice President-Executive H. E. Chubbuck, recently has contracted with the Union Switch & Signal Company for the largest amount of signaling apparatus ever installed on a trolley interurban road.

Semaphore signals to the number of 131 will be placed on the lines between Peoria, Bloomington, Decatur, Danville, Springfield, Ill., and St. Louis.

These signals are being distributed over four sections of continuous blocking for the protection of sidings and curves, 101 being employed for a total of 27 sidings and 60 miles of road. The remaining 30 signals will protect 35 miles of road divided into 15 "curve protections" of two signals each.

The blocks in the continuous signaling average two miles in length, and extend from siding to siding. The meeting of trains and the operation between sidings are controlled by home signals and their respective distant signals located in the immediate vicinity of the sidings.

In addition, at a number of points where the view is obstructed, signals have been provided to protect train movements.

The Illinois Traction System, on which these signals are to be installed, is a high-speed interurban road operating about 500 miles of line through the most thickly populated section of Illinois. It traverses a very rich farming and coal mining territory, and reaches most of the large cities of the state, thereby making possible an extensive express and through passenger business in addition to the handling of grain, coal and miscellaneous freight.

This installation is receiving the personal attention of Mr. Chubbuck on account of its extensive application to the protection of this class of traffic, while the erection is being directed by John Leisenring, signal engineer of the road.

Q. & C. BONZANO ROLLED STEEL STEP JOINT.

For a good many years it has been necessary to make step or compromise joints of cast steel, or maleable iron, or to upset angle bars. Within the past year, however, the Q. & C. Co., New York City, has perfected and placed on the market the Q. & C. Bonzano Rolled Steel Step Joint which combines the advantages of strength, simplicity of design, and consequent ease of application with low cost. It is claimed that this step joint develops about 500 per cent greater efficiency than cast steel step joints of corresponding sections.

One of the principal points of advantage claimed for the Q. & C. Bonzano rolled steel step joint is that it makes the joint as strong as the larger section of the rail in the combination to be joined. This is accomplished by making the joint of the same cross section throughout, which cross section equals that of the larger rail in the combination.

The Q. & C. Bonzano rolled steel step joint is made of open hearth steel, annealed, and the fit is absolutely perfect.

These joints are on exhibition at Spaces 120 and 139 at the Coliseum.

SIGNAL LAMPS.

One distinct feature that is of interest at the exhibit of the Armspear Manufacturing Company, New York City, is the Twentieth Century signal lamp, which is built to spread light over a wide visual angle. This feature is appreciated by locomotive engineers who are able with a lamp of this type to get a good signal on curves. This lamp is also built for train, engine and semaphore service.

The Armspear bayonet catch outside wick adjustment steel guard lantern No. 106D does not require the opening of the top and removal of the globe in order to light the wick, and this improvement has effected a large saving in the breakage of globes.

A full line of steel signal lamps, including the Railway Signal Association recommended standard semaphore lamp with perfect watershed, is also on display.

EXHIBIT OF ADAMS & WESTLAKE COMPANY.

The exhibit of the Adams & Westlake Company, Chicago, at the Coliseum, spaces 83 and 84, is one of the most attractive there. The company made special preparations this year to get up an exhibit that would do justice to its products. The entire exhibit is made up of the standard Adams & Westlake lamps, especially made of solid brass and finished with gold lacquer. The lamps are all of the standard size, shape, and style that the company furnishes for every conceivable use in connection with railways, and they only differ from the stock lamps in the material from which they are made.

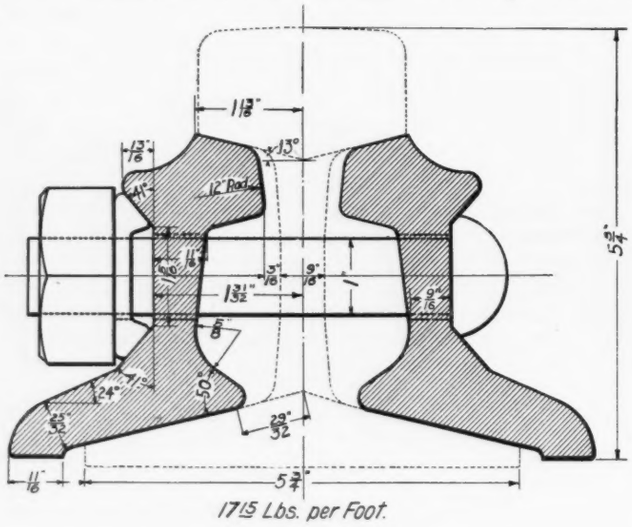
In addition to the lamps, there is an interesting collection

of lamp sections and parts, from which it is easy to see how each piece of material that enters into the construction of a railway lamp or lantern is made, and how the finished product is put together. The name "Adlake" is shown over one of the entrances in illuminated letters which form the front of one of the company's train indicating lamps. The line of padlocks, one of the Adams & Westlake specialties, is also prominently displayed. From the balcony the red, green and yellow lights look like a miniature yard at night.

The train indicating lamp is adapted for carrying train numbers, both regular and special, for day and night indications so that they may be easily read and errors in train identification avoided. The locomotive lamp is placed on the side of the boiler, back of the headlight, in a position where the numbers are not dimmed by the headlight; and the angle at which the lamp is placed is such that train numbers may be easily read by approaching and passing trains. The lamp will also permit of being carried on the caboose, where the easily readable letters and numbers can hardly fail to be properly observed.

REINFORCED ANGLE BAR.

The reinforced angle bar joint, manufactured by the Cambria Steel Company, Johnstown, Pa., is designed to obtain the maximum section and carrying capacity. In this bar provision is made to overcome the weakness of the upper side of the ordinary angle bar, which breaks because of the joint springing upward between the wheel loads and causing a tensile stress in that member, instead of the compression which occurs when the load is directly over the joint. Another weakness of the common angle bar is that the base member is too thin where it unites with the web, frequently resulting in buckling. In correcting these defects, the web of the reinforced angle bar is moved far enough from the

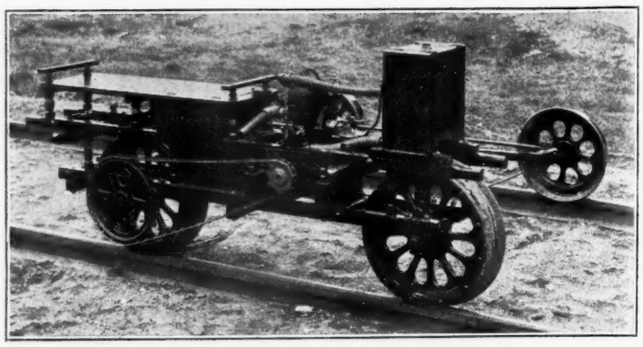


Reinforced Angle Bar.

web of the rail to permit of the strengthening of this base member and provide ample clearance for a square nut on a 1-in. bolt. The moving of the web of the angle bar from the web of the rail also makes possible an increase in area of the head in addition to that of a laterally extending reinforcing rib to provide against breaking of the bar at this point. The spring washer fulfills two functions: first, that of providing a flat frictional surface of large area for the nut, and second, that of a spring washer of great strength, requiring a compression load of from 10,000 to 15,000 lbs., or from five to seven times more than the ordinary nut locks. The bars are made in standard open-hearth steel; in open-hearth steel from .45 to .55 carbon and hot finished; and in open-hearth steel from .45 to .55 carbon, hot finished and oil treated.

VELOCIPEDE CAR MOTOR.

The Kalamazoo Railway Supply Co., Kalamazoo, Mich., has on exhibition at spaces 23, 24 and 25, in the Coliseum, a motor designed for use with a velocipede car. This motor can be installed on a car by anyone, without previous experience. The engine is small and compact, being only 11¼ in. high from the center of the crank shaft. It weighs



Velocipede Car Equipped with Kalamazoo Motor.

but 73 lbs., and yet is strong and durable. It develops about 2 h. p. when running at normal speed and if operated at higher speeds can develop 2½ h. p. The accompanying cut shows this motor attached to an ordinary 4-wheel car. Such a car is very convenient for signal maintainers, telegraph linemen, section foremen, or others desiring a light car for inspection purposes.

SEPARABLE SWITCH POINT.

The Economy Separable Switch Point Co., Inc., Louisville, Ky., makes the Economy separable switch point, which is being placed on many roads in this country. A considerable saving in cost of switch maintenance is claimed for this point, especially when applied to new switch points. New Economy points can be applied to old switch points without taking the switch out of the track, and this operation can be repeated as often as necessary, until the entire switch point is worn out.

The Economy separable switch points are manufactured

Running Side of Economy Separable Switch Point, Attached to an Ordinary Point Ready for Installation in the Track.

from a high grade of open-hearth acid process steel, especially prepared for resisting wear, to enable them to adjust themselves to the worn condition of the main or stock rail, thereby avoiding the expense of changing the stock rail in installing the switch points in the track. They are also made of the highest and most reliable grade of manganese steel.

This company has contracts with some of the largest and

Side of Economy Separable Switch Point, Designed to Fit Against the Stock Rail.

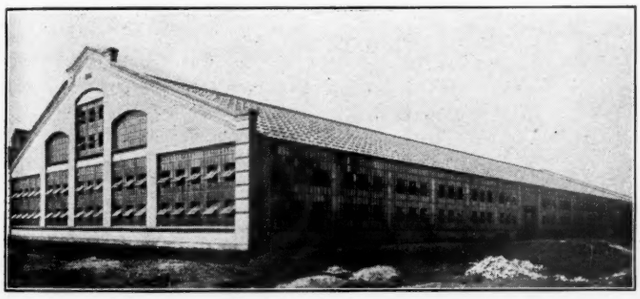
best equipped frog and switch companies in the country, viz.: Cleveland Frog & Crossing Company, Cleveland, Ohio; Ajax Forge Company, Chicago; Conley Frog & Switch Company, Memphis, Tenn.; Elliot Frog & Switch Company, East St. Louis, Ill.; Weir Frog Company, Cincinnati, Ohio; Kilby Frog & Switch Company, Birmingham, Ala.; The Guerber

Engineering Company, Bethlehem, Pa., and the St. Paul Foundry Company, St. Paul, Minn. To these companies the railways ship their old and worn switch points (thereby saving them from the scrap pile) for application of the Economy separable switch points.

FENESTRA.

Fenestra solid steel window sash, for factories, power houses, etc., manufactured by the Detroit Steel Products Company, Detroit, Mich., is a new product of steel. For scores of large new plants that have been built recently, this material has been specified. In several important large plants, steel columns and curtain walls of Fenestra design have replaced the customary brick wall, with satisfactory results. It makes a wall of glass with a steel frame that offers the least obstruction to the light, so that the interior of a building is flooded with soft light, instead of depending on small windows in a brick or concrete wall. When the usual window is retained, the Fenestra sash makes it possible to have larger openings with a convenient plan of ventilation.

The Fenestra sash is made of steel bars, rolled in a special section. It is made in units, each unit containing as many panes of glass as may be specified. The peculiar and original feature of this steel sash, covered by patents, is in the joint where the bars cross. The bar, which is to form the vertical member in a sash, has a slot punched in the web. The head and the remaining outer edge of the web are then spread so the horizontal bar can be inserted. The portion of the web which has been bent out is then pressed into a notch in the horizontal bar. This makes a very strong joint, and makes it possible to build walls with openings of large area



Application of Fenestra to the Plant of the Detroit Steel Products Company.

with light steel bars. While it is not expected to meet the æsthetic requirements of an office or public building, it is particularly suitable for factories, warehouses and other structures in which perfect light and economy in cost and maintenance is the prime consideration. Its application to the factory of the Detroit Steel Products Company is here illustrated.

Double flange bars are used for the outside members of the sash, of a special section which is adapted to either brick work or concrete. Only two sections of bars are used in the manufacture of the standard sash, the T-bar for the inner mullions and the double flange for the outer members. The sash is shipped in units, unglazed, and the standard construction is adapted to take standard sizes of glass from 10x16 in. to 12x18 in. panes. One of the important features in the construction of windows or walls of this type is the opportunity for ventilation. Each unit of the sash is readily arranged to carry a tilting inner sash, or two ventilating sections, which open and close together by the same mechanism. In this way, 20 to 30 per cent. or more of the total area can be used for ventilation.

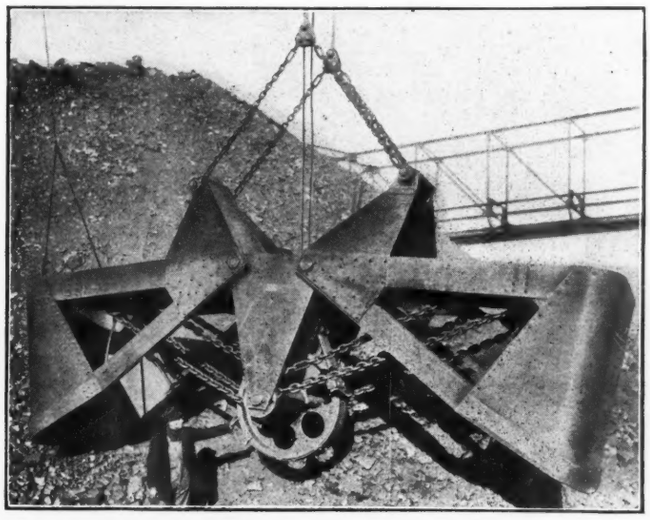
While the cost of steel window sash is necessarily a little greater than wood, the maintenance and depreciation charges are light. If the mullions are kept painted their life is practically indefinite, and even if painting is neglected corrosion does not have the same effect that it would have on sash constructed of sheet steel. The maintenance of windows in a large plant is usually a considerable item of expense.

Light has been found an important factor in efficiency, especially where a large number of operatives are engaged in work which requires constant attention of the eye. A large window area affords the largest possible volume of soft light which does not throw shadows on the work, and at the same time it creates a more cheerful atmosphere for the operatives. An appreciable gain in efficiency has been noted in large plants where the Fenestra system of lighting has been adopted. The perfect ventilation secured by this construction has also been found to have a marked influence on the health of the operatives.

ANDRESEN-EVANS GRAB BUCKETS.

The accompanying illustration of an eight cubic yard grab bucket in operation on a large conveyor bridge on a coal dock at Superior, Wis., shows a grab bucket that has been perfected by the Andresen-Evans Company, Chicago, for handling all kinds of bulk materials, especially coal, crushed stone, gravel and sand, and for excavating and dredging. These grab buckets are made in all sizes, from one cubic yard to eight cubic yards capacity, and for operation with two, three or four lines.

The distinctive features claimed for these grab buckets



Andresen-Evans Grab Bucket.

are: The path of travel of cutting edges and inclination of trays are such as to cause the scoops to dig into, and not out of, the material; the direction of pull of the closing chains pulls the scoops down into the material; the opening is 50 per cent. greater than clam shells. The wide opening is of especial advantage in unloading boats, barges or cars, reducing hand shoveling to a minimum and getting loads where clam shells would not.

These buckets can be used on locomotive cranes, traveling cranes, derricks, dredges, skid excavators, or any equipment having two drums for hoisting, one drum for the closing and hoisting line or lines, and one drum for the hold or dumping line or lines. They are especially adaptable for locomotive coaling stations, in connection with locomotive cranes, and show economy in that the ratio between the dead weight of bucket and weight of material handled is a minimum. The builder reports that in a recent test, unloading a large lake boat, one of these grab buckets averaged 62 per cent. more coal per trip, when taking out the coal directly beneath the hatch, and 71 per cent. more

coal per trip, when cleaning up, than a clam shell of the same rated capacity. They have also been used for stripping work in hard clay, sand and gravel, for concrete mixing plants, and by contractors in excavating for dam sites, sewer work, digging channels, etc. For many classes of excavating these grab buckets, when mounted on long boom excavator machines, will handle material cheaper than steam shovels, on account of the long reach and the ability to dig any required depth, making unnecessary frequent shifts of machinery and tracks.

KENNICOTT WATER WEIGHER.

The Kennicott Company, Chicago Heights, Ill., manufactures a water-weighing device that furnishes a continuous, dependable record of the weight of boiler feed water evaporated. Where a continuous record of the boiler feed water evaporated is not kept there is usually loss of money both in buying and burning the fuel. In a 500-h. p. plant, operating 12 hours per hay, if the saving amounts to only 1½ cents per 1,000 pounds of water evaporated the total will be over $1,000 per year.

The Kennicott water weigher receives water from open heater, standpipe or any other source and delivers it in unit charges of uniform weight into any suitable storage

Kennicott Water Weigher with Storage Tank.

tank. When used in connection with a storage tank, as shown in the accompanying illustration, the supply to the weigher may be regulated by a balanced valve in the inlet, governed by a ball float in the storage tank, which insures that the storage tank is always full of water. A counter registers each unit charge delivered by the weigher and an accurate record of the weight of water is thus obtained.

The wide fluctuations in rate of supply, which are so common in boiler feeding, cause inaccuracy in meters and some other measuring devices. The Kennicott water weigher is unaffected by variations in rate of supply, weighing with equal accuracy whether water is delivered to it at a low or at the maximum capacity of the weigher. Each Kennicott weigher is given a most careful test for accuracy and capacity at the actual temperatures at which it is to be used. Each weigher is assembled and receives an individual test and calibration, the unit charges being accurately weighed on scales, and the exact weight of the unit charge thus determined. A test report and certificate of guaranteed accuracy and capacity accompanies each weigher, which is guaranteed to record the correct weight of water to within ½ of 1 per cent. of absolute accuracy.

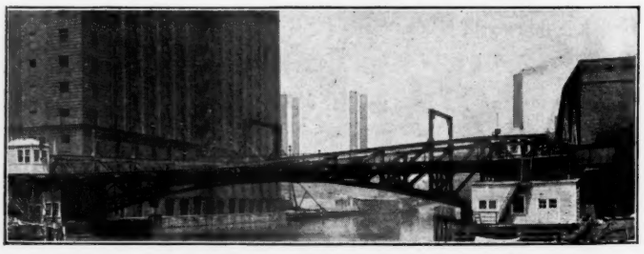
GALVANOMETER TYPE A. C. TRACK RELAY.

The Union Switch & Signal Company, Swissvale, Pa., makes a galvanometer type a. c. relay, designed originally for use on electric roads. When used on steam roads the mechanical construction is the same, the winding only being changed. The two large coils constitute the field winding, which is connected to a local source of alternating current. The moving coil is the armature winding, which is connected to the track. The shaft carrying the moving coil is connected by cranks and a link to a second shaft which carries the contact springs.

To operate the relay it is necessary to have current flowing to both windings, and these currents must be in a certain direction relative to each other. In case direct current flows through the armature it cannot operate the relay since the fields are energized with alternating current. The relay contains no iron in its magnetic circuit, and therefore it cannot be held closed by direct current flowing through the armature after the alternating current has been shunted off. If the polarity of adjacent track circuits is reversed, current coming from the adjacent track circuit in case the insulation joints are broken down, will tend to open the relay contacts. The clearances in the relay are large, and all parts are easily inspected.

STRAUSS BASCULE BRIDGE.

The accompanying illustration shows the Strauss trunnion bascule bridge over the Chicago River on Polk street, Chicago. It is a highway structure carrying a double-track street railway line. It has a clear span 140 ft. The bridge is of the cantilever type, with the exception that there is no anchorage, the lower end of the bottom chord coming to a bearing on



Strauss Bascule Bridge at Polk Street, Chicago.

the front of the pier at a sufficient distance in front of the trunnion so that the live load on the leaf is overbalanced by the total dead reaction on the trunnion. This feature of the Strauss cantilever design contributes materially to the rigidity of the cantilever type and this rigidity is further increased by a motor-driven lock which connects the leaves at the center.

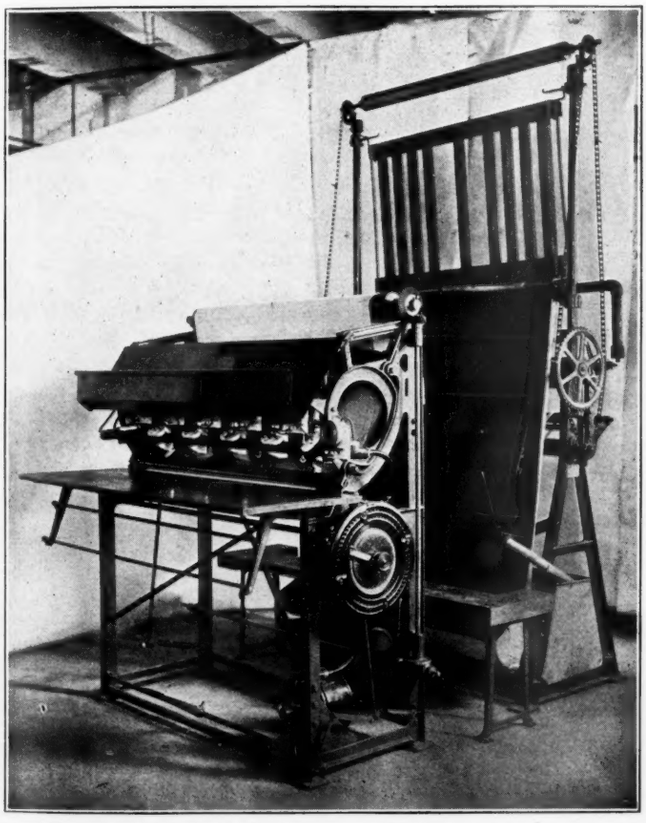
This bridge is the first deviation of the city of Chicago from its standard type of trunnion bridge. The design originally selected for this crossing cuts off one of the tracks of the Chicago Great Western on the east side of the river, and, as a result of a suggestion by the railway company, the city took up the question of finding a design which would leave this track unchanged and still give the full width of clear channel without exceeding the appropriation provided for the construction.

It was found that the Strauss design fully met these requirements, the cost being about $24,000 less than the city's

own type, and the city, therefore, contracted with the Strauss Bascule Bridge Co., Chicago, for the plans and royalty. The structure has now been in service about nine months and has given excellent satisfaction. This bridge, and also the Strauss bridge at Kinzie street, on the Chicago & North Western, can now be seen in operation.

PEASE STANDARD CONTINUOUS BLUE PRINTER.

The tendency on the part of manufacturers and railway engineers toward the use of smaller blue prints for shop use has induced the C. F. Pease Company, Chicago, to introduce a small continuous blue printer. The illustration shows the Pease standard continuous blue printer for tracings up to 30 in. wide, with only three arc lamps of low amperage. The 24-in. machine uses but two arc lamps and has a capacity of fifty to seventy-five 24-in. x 36-in. prints per hour, or double that quantity of 18-in. x 24-in. prints, which fulfills the requirements of many manufacturers, while to those desiring a larger output or larger prints the



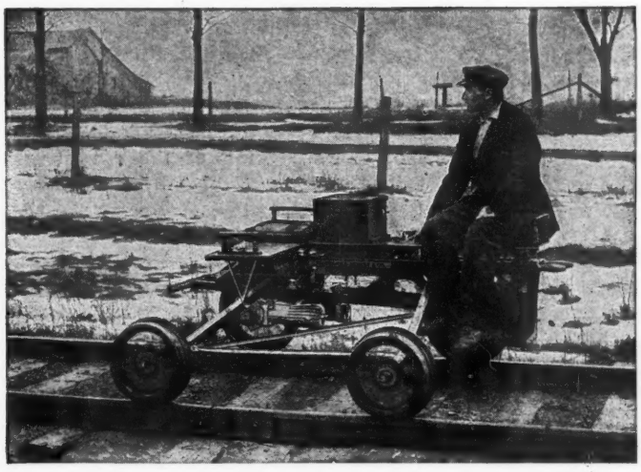
Pease Printing, Washing and Drying Machine, with Gas Dryer.

machines can be furnished in any width up to 54 in., the number of lamps depending on the width of the machine. The 24-in. printer occupies no more space than a small drafting table and can readily be placed in a corner of the drafting room, as it is almost noiseless. This printer will compare favorably in price with the vertical printer and occupies no more space, while it is always ready for instant use and no time is lost in loading and unloading. All tracings are fed over the feeding table, on top of the sensitized paper right side up. The printer may be used for printing either from sheets or rolls as desired. The paper and tracings are carried down past the bent glass by an endless canvas belt and drop into the tray below, as shown in the cut, from which they can be taken out by the operator from the front of the machine. Any width sheet up to the width of the machine can be printed and the prints can be made up to the width of the machine and the prints can be made any length in one place. It is possible also to print any portion of a tracing without running the entire tracing through. With one of these printers it is possible to connect at any time with the Pease automatic washing and drying machine and the Pease direct white print apparatus, equipping the operator to print, wash and dry by one continuous operation, doing away with the time and labor consumed in washing and drying, and producing prints free from stick marks or distortions.

Where space is too limited to warrant the installation of an automatic washing and drying machine in connection with the printer, much room can be saved by the installation of a Pease sheet washer instead of a flat tray and the necessary drying rods. These sheet washers are placed against the wall and the washing and drying apparatus takes up no more room than a radiator, while it is possible to wash all sizes of prints up to 42 in. x 72 in. This also avoids wet or sloppy floors, as the prints are washed with a spray of water which passes off into the drain pipe. Thus only fresh water is used and better prints are obtained. This sheet washer is illustrated herewith. These machines can be seen in operation at the Coliseum, sections 161-162.

NO. 28 MOTOR CAR.

About the time the first automobiles were brought out, Fairbanks, Morse & Co., Chicago, began to make gasoline motor cars for railway service. The first cars built were like the first automobiles, rather crude and cumbersome, but they did run and were the basis on which to work for perfection. In those days the problem of obtaining a good combustible mixture of gasoline and air was one of the



No. 28 Fairbanks-Morse Motor Car.

most difficult to overcome. All kinds of mixing valves and carburetors were tried and used, but the automatic float-feed type had not been perfected. The first Fairbanks-Morse motor cars were equipped with a large galvanized iron shell, inside of which was a fine wire gauze over which the gasoline passed. The air drawn through this shell evaporated the gasoline on the gauze, forming a mixture which could be exploded when drawn into the cylinder, compressed and ignited by a spark. The spark was produced mechanically, which called for complicated moving parts to wear out and get out of adjustment. Now all this is changed. The most highly perfected automatic float-feed carburetor is furnished on all cars and the jump spark system of ignition employed.

This company has developed cars to meet the needs of

all the officers of a railway for rapid and convenient transportation over the line. The superintendent's car is, of course, of the automobile type, having comfortable seats for long trips and is usually operated on train orders, being too heavy to lift off and on the track readily. For other railway men, track supervisors, bridge inspectors, signalmen, linemen, etc., smaller inspection cars have been designed, having a carrying capacity of two or three men, but with the weight kept down so that one man can remove them from the track.

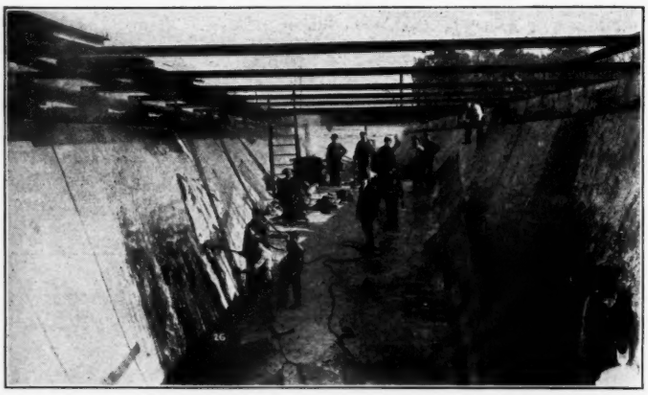
The No. 28 car exhibited by Fairbanks, Morse & Co. is their latest car of the light type and after a year's testing and experimenting is being offered to railway men this spring. It has several new and interesting features. The frame is all steel, pressed to shape, all boring being done by jigs at one time, insuring interchangeability. The engine is of the air-cooled, two-cycle type, which eliminates all valves, pawls, cams, sprockets and chain. It is direct connected, one on each side, to the front wheel axle, which is in reality the crank shaft. Cylinders are enclosed and cannot be damaged by dirt or sand cutting them. Lubrication is an important feature, the oil and gasoline being mixed before they are placed in the gasoline tank. This mixture passes from the carburetor into the crank case, then into the cylinder, insuring a positive and automatic lubrication system, which stops when the car stops. Two switches are provided so that one cylinder can be cut out entirely, with no waste of gasoline, as the intake pipe is fitted with a valve to cut off supply of gas to either cylinder. The car's speed is from 8 to 30 miles per hour under absolute control of the operator.

THE WATERPROOFING OF THE BRANDYWINE ARCH ON THE BALTIMORE & OHIO RAILROAD.

In connection with the general work of strengthening bridges on the Philadelphia division of the Baltimore & Ohio, a new double-track stone arch viaduct has recently been completed over Brandywine creek, Wilmington, Del., replacing the pin-connected double-track deck Pratt truss erected in 1882. On account of a general realignment the new structure was built 140 ft. south of the old bridge. The viaduct is 746 ft. long and 114 ft. high from mean low water to the top of the coping. It is composed of a series of seven semi-circular arches, three of 100-ft. spans, two of 90-ft. spans and two of 80-ft. spans, arranged symmetrically about the center. The arches were supported by six piers and two abutments, the center piers being 12 ft. wide at the springing line, while the two piers at the intersection of the 80-ft. and 90-ft. arches were 11 ft. wide. At the outer ends of the 100 ft. arches abutments were built having a width of 17 ft. at the springing line. The entire structure, except the foundations, was built of composite masonry faced with Ohio sandstone.

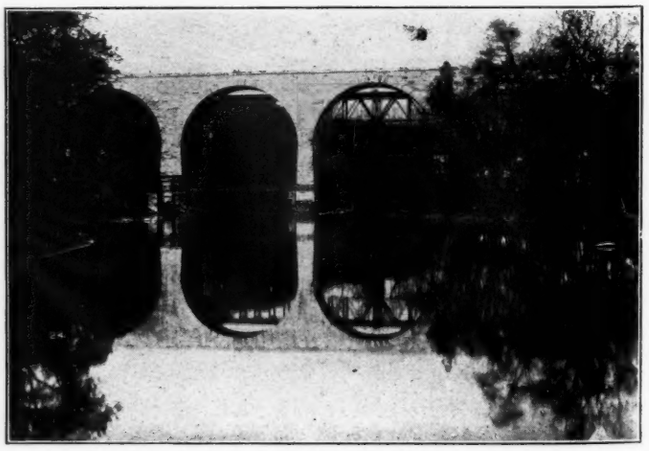
From the nature of the situation, the work was planned to be distinctly permanent. Consequently, great care was taken to select a waterproofing material to protect the structure from the damaging action of water and frost. Because of the high fill over the structure any repairing to the waterproofing would be very expensive; also it was necessary to use a method and a material sufficiently adaptable in its make-up and application to be flashed into the sharp angles and over the steep slopes readily with no danger of forming air pockets or bad joints. To meet these conditions the following specifications were drawn up:

"On the clean and dry surface of the concrete there shall first be applied, with brushes, a coating of Sarco concrete primer, which coating, as applied, shall be thin enough to penetrate the recesses of the concrete, forming an anchorage for the subsequent waterproof coating. After the priming coat has been allowed to dry there shall then be applied, with mops, a heavy coating of Sarco No. 6 waterproofing, which has been heated to a temperature of 450 deg. F., and while the material is still hot there shall then be introduced a layer of 8-oz. Open Mesh Burlap, all carefully laid down and free from folds or pockets. The surface of this burlap shall then be heavily mopped with waterproofing and two more layers of 8-oz. Open Mesh Burlap laid in the same manner, making a 3-ply burlap waterproof mat, all thoroughly saturated, cemented and bonded together and to the concrete with waterproofing. While the final swabbing coat is still hot it shall be sanded with Torpedo sand to a walking surface."



Applying the Waterproofing.

In doing the work a 3-ply waterproof mat was first laid over the tops of the arches, into the valleys between the crowns of the arches and up the parapet walls as high as it was possible without the use of staging, the strips of burlap being laid lengthwise of the bridge. The mat was then applied to the parapet walls, the strips being laid perpendicularly up the walls and lapping over that portion already laid lengthwise of the structure. Painters' platforms slung from rails laid from coping to coping were used in applying the mat to the parapet walls. In the valleys between the crowns of the arches the height to the coping was 25 ft.,



The Brandywine Arch.

making it necessary to use two sets of staging. The top edge of the waterproof mat was sealed in the recess left under the coping by filling the recess with pure Sarco No. 6 waterproofing, the material being held until cooled by a clay stop. This seal was then plastered over with cement grout to carry the water from the coping out toward the center of the bridge.

The drainage of this arch structure was in the valleys between the crowns of the arches, downspouts carrying the water to deep holes leading out of the masonry piers. Great care was taken to flash around the drains to obtain a per-

fectly tight seal. After the completion of the waterproof mat a 2-in. layer of concrete was laid over the crowns and valleys of the arches and part way up the side walls, to protect the mat from mechanical injury, due to the dumping of the filling material, consisting of dirt, cinders, quarry chips and clay, from the level of the top of the coping. On completion of the fill the structure was ready for the track-laying.

The care taken in this work is an example of the advance made in the design of permanent structures and a recognition of the fact that in order to be permanent a structure must be waterproof and thus be free from all decompositions resulting from the presence of water in the masonry or concrete.

The waterproofing work was at all times directly in charge of the Standard Asphalt & Rubber Co., Chicago, Ill., and under the direction of one of its engineers. It was under the supervision of the following officers of the Baltimore & Ohio: A. W. Thompson, chief engineer; W. S. Bouton, bridge engineer; J. T. Wilson, district engineer; F. W. Strouse, assistant engineer and J. G. Teders, resident engineer on the on the ground. Charles A. Sims was the contractor for the construction of this arch.

Construction Work Under Way.

FIREPROOF COALING STATION FOR ELGIN, JOLIET & EASTERN.

The Elgin, Joliet & Eastern has recently had built at its roundhouse at Waukegan, Ill., a new fireproof structural steel locomotive coaling station, which is illustrated herewith.

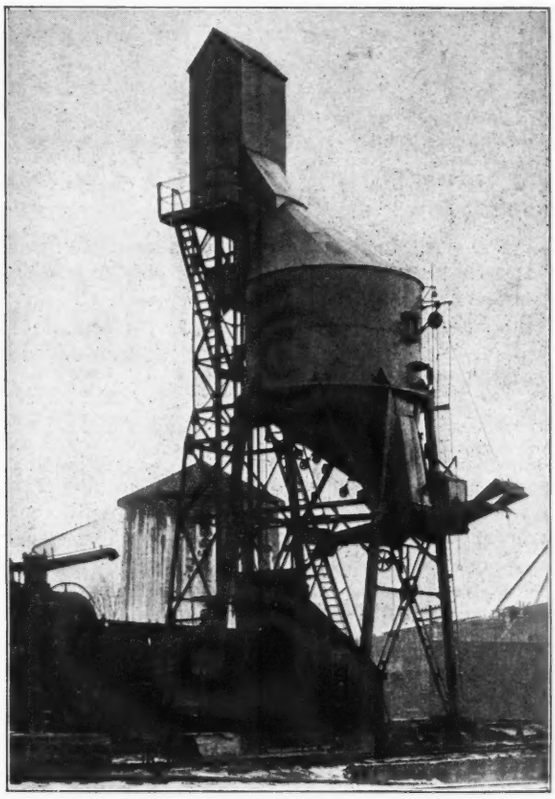
The station has a storage capacity of 100 tons of bituminous coal and 8 tons of dry sand, and is designed to coal and sand locomotives on two tracks. The coal is brought to the station on the receiving track at the rear of the plant in hopper bottom cars and dumped into a 26-ft. concrete receiving hopper. The rails of this receiving track are supported over the hopper on 24-in., 80-lb. I-beam girders. The track hopper is lined with 1 in. of neat cement, sidewalk finish, with well-rounded valleys to the measuring feeder. This method of lining track hoppers has proved more successful than wood plank lined with steel, which will eventually rot out.

The coal from the receiving hopper flows by gravity into a Barrett revolving measuring feeder, which measures 1½ tons of coal and discharges its load automatically into the elevating bucket, preventing overflowing of the bucket and flooding of the pit. This device is so designed that when in the act of discharging a measured quantity of coal into the elevating bucket, it closes the opening in the track hopper as an undercut gate. As the bucket is elevated, the revolving feeder automatically rotates back into its original position, opening the gate in the receiving hopper; and it is then in a position to receive another measure of coal. It rests in this position until the returning empty bucket descends and is again filled from the feeder.

This plant is designed to elevate 40 tons of coal per hour with a single bucket balanced with counterweight. The bucket elevator is operated by a 15-h.p. General Electric motor, taking 3-phase, 60-cycle alternating current at 220 volts, and equipped with solenoid brake, circuit breaker, special controller with Hatch limit switch, a device to cut off the current and stop hoisting when the bucket is carried beyond the discharge point by a careless operator. This device makes the station fool-proof. The motor is directly connected to a 15-h.p. reversible hoisting drum.

The round tank receptacle of the pocket which holds the coal is made of $\frac{5}{16}$-in. and ¼-in. steel plate, properly reinforced with a plate girder at the base to prevent distortion. The balance of the station is of structural steel, the columns being of built-up angle and plate construction.

The hoist house and canopy over the tower are covered with corrugated steel. The entire structure rests on concrete foundations, and the bucket pit is waterproofed.



Coaling Station at Waukegan, Ill.

The contract for this complete "counterbalanced bucket" plant was awarded to the Roberts & Schaefer Company, Chicago, the original promoters of the Holmen balanced bucket type locomotive coaling station.

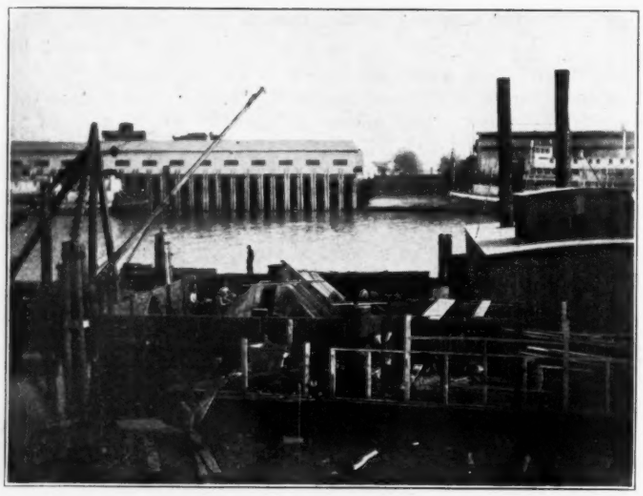
A small operating model of the coaling station described above may be seen at this company's exhibit in the Coliseum, spaces 78 and 97.

BRIDGE FOUNDATION WORK.

The Missouri Valley Bridge & Iron Co., Leavenworth, Kan., is now building a bridge across the Sacramento river at Sacramento, Cal., for the Northern Electric Company. At this point it was necessary to resort to pneumatic caisson methods. One of the caissons was constructed on a barge and then moved into place, as shown in the accompanying photograph. With some of the other piers it was possible

to build the caissons on shore and then float them into position.

In addition to the usual run of smaller work this company has recently completed the construction of new concrete piers extending 70 ft. below low water by the pneumatic process in connection with the rebuilding of the



Building Caisson, Sacramento River Bridge of the Northern Electric.

bridge of the St. Louis Southwestern across the Arkansas river at Rob Roy, Ark. This company also had charge of the reinforcing of the Pecos viaduct across the Pecos river in Texas on the line of the Southern Pacific, and it recently took a contract for a number of deep foundations for the National Railways of Mexico.

STEEL WATER TANKS.

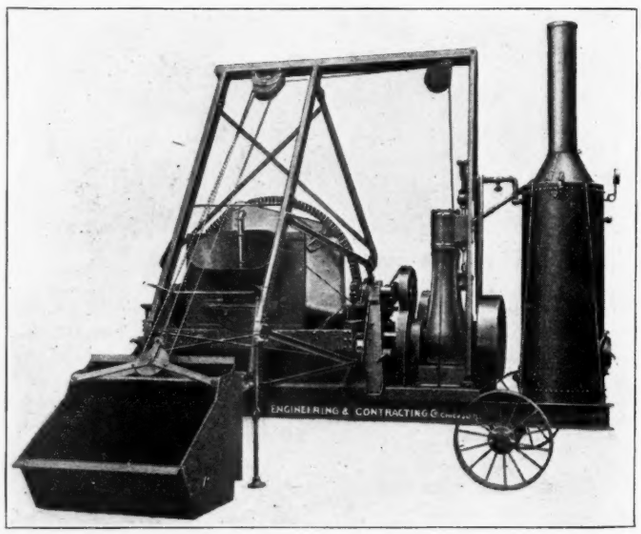
The accompanying cut of water tanks on the Pennsylvania Railroad at Charleroi, Pa., shows the difference in appearance between wood and steel tanks. The steel tank shown is one of the patented tanks built by the Chicago Bridge & Iron Works, Chicago. Its special features are the elliptical bottom and the large riveted steel riser pipe

Water Tank on Pennsylvania Railroad at Charleroi, Pa.

or mud drum. The mud drum is made of sufficient diameter to prevent freezing, thereby eliminating the need of any temporary wooden frost casing and putting the tank into the class of permanent structures. The mud drum also acts as a settling basin and is equipped with a wash-out valve at the bottom so that sediment can be washed out at any time without interrupting the service of the tank. The elliptical bottom not only does away with the excessive weight of an I-beam platform but it also makes all the tank plates readily accessible for inspection and painting. At the same time the head to be pumped against is no greater than for the ordinary flat bottom tank. Tanks of this design are in use by 28 of the railways of this country, in capacities up to and including 500,000 gallons, while the builders claim that such tanks can be built in capacities of over 1,000,000 gallons.

CONCRETE MIXER CHARGING ELEVATOR.

Loading concrete mixers by hand labor has long been regarded as an expensive method, especially on small jobs, where it was necessary to move the machine frequently, requiring the building of a platform runway at each setting of the mixer. To eliminate this the Municipal Engineering & Contracting Company, Chicago, has constructed a large elevator to be used in connection with its Chicago improved cube mixers. This elevator has an important feature of special value in railway work, in that it requires no ground supports, and it is, therefore, immaterial whether the surrounding surface be higher or lower than the ground on which the machine is located. Another advantage is that such an elevator offers no extra difficulty in moving the mixer. The elevator consists of a double track, or guides, set at an angle and firmly attached to the mixer



Chicago Improved Cube Mixer, With Elevator.

frame. On this track is mounted a traveling carriage and a bucket of sufficient capacity to hold an entire batch. The bucket is filled within 12 in. of the ground and drawn to the top by a cable wound on a hoisting drum, which is also attached to the mixer frame, and the operation of the hoist, attending of the engine and charging and discharging of the mixer are all performed by one man. When it is desired to lift the bucket, or hopper, the hoist is started and the bucket rocks over until guide flanges on either side engage the supporting rails of the carriage; and in this position it is carried erect to the top of the elevator, when the door in the bottom is released, instantly discharging the entire batch into the mixer. The hopper is then immediately lowered to the ground to be refilled while the batch is being mixed, and, since the mixer is in constant operation and the charging and returning of the bucket to the ground require but a moment, no time is wasted. All the heavy work of elevating the material is done by the machine and consequently fewer men are required.